



PUBLIC NOTICE

Federal Communications Commission
445 12th St., S.W.
Washington, D.C. 20554

News Media Information 202 / 418-0500
Internet: <http://www.fcc.gov>
TTY: 1-888-835-5322

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**APPLICATION PROCEDURES FOR
BROADCAST INCENTIVE AUCTION SCHEDULED TO BEGIN
ON MARCH 29, 2016**

TECHNICAL FORMULAS FOR COMPETITIVE BIDDING

AU Docket No. 14-252
GN Docket No. 12-268
WT Docket No. 12-269

Released: October 15, 2015

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I. GENERAL INFORMATION

A. Introduction

1. In the *Auction 1000 Bidding Procedures PN*,¹ the Commission established the bidding procedures for both the reverse auction and the forward auction.² Pursuant to the Commission’s direction,

¹ See *Broadcast Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, AU Docket No. 14-252, GN Docket No. 12-268, WT Docket No. 12-269, MB Docket No. 15-146, Public Notice, 30 FCC Rcd 8975, 8979–80, para. 3 (2015) (*Auction 1000 Bidding Procedures PN*). In the reverse
(continued....)

this Public Notice (“*Auction 1000 Application Procedures Public Notice*” or “*Auction 1000 Application Procedures PN*”) establishes final application procedures for the reverse and forward auctions, provides detailed information, instructions, and deadlines for filing applications, and finalizes certain post-auction procedures established by the Commission’s prior orders.³

2. This Public Notice includes an attachment with the final appendices providing the technical details implementing the Commission’s decisions in the *Auction 1000 Bidding Procedures PN* regarding the clearing target determination procedure, the final television channel assignment plan, and the assignment of frequency-specific licenses to forward auction clock-phase winning bidders, as well as algorithms for reverse and forward auction bid processing.⁴ An additional attachment provides information relating to the determination of opening prices for each bid option available to each eligible broadcast television licensee in the reverse auction, including the process for identifying “not-needed” stations.⁵ Finally, this Public Notice includes as an attachment information on the PEA-by-PEA spectrum reserve eligibility of nationwide providers.⁶ Opening prices for each bid option available to each eligible broadcast television licensee in the reverse auction will be released in a separate public notice in the near future. Additional data and information related to the broadcast incentive auction, including the final constraints and the associated supporting files, is being made available on the Auction 1000 website (<http://www.fcc.gov/auctions/1000>) contemporaneously with the release of this Public Notice.

B. Background of Proceeding

3. Auction 1000 (including Auctions 1001 and 1002) will be conducted pursuant to Title VI of the Middle Class Tax Relief and Job Creation Act of 2012 (“Spectrum Act”),⁷ which authorizes

(Continued from previous page) _____

auction, eligible television broadcast licensees may bid to voluntarily relinquish spectrum usage rights, and the forward auction will offer new flexible-use licenses in a repurposed portion of the UHF which will be known as the 600 MHz Band.

² The *Auction 1000 Bidding Procedures PN* resolved issues raised in the *Auction 1000 Comment PN*. *Comment Sought on Competitive Bidding Procedures for Broadcast Incentive Auction 1000, Including Auctions 1001 and 1002*, AU Docket No. 14-252, GN Docket No. 12-268, WT Docket No. 12-269, Public Notice, 29 FCC Rcd 15750 (2014) (*Auction 1000 Comment PN* or *Comment PN*). The *Auction 1000 Comment PN* sought public comment on the detailed procedures necessary to carry out the incentive auction consistent with the rules and policies adopted in the *Incentive Auction R&O* and related proceedings. *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6567, 6574, para. 15 (2014) (*Incentive Auction R&O*) (modified by Erratum (rel. June 3, 2014)); see also *Policies Regarding Mobile Spectrum Holdings*, WT Docket No. 12-269, GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6133, 6193, para. 146 (2014) (*Mobile Spectrum Holdings R&O*) (establishing a market-based 600 MHz Band spectrum reserve for eligible entities).

³ See *Incentive Auction R&O*, 29 FCC Rcd at 6574, para. 15 (preserving Wireless Telecommunications Bureau’s authority to adopt final incentive auction procedures “concerning those matters that it typically handles under existing delegations of authority”).

⁴ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8979–80, para. 3. These final technical appendices reflect modifications made to the detailed proposals contained in the *Comment PN* Appendices as a result of the Commission’s decisions in the *Auction 1000 Bidding Procedures PN*.

⁵ Not-needed stations are stations that at any clearing target will always have a feasible channel assignment. *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9022, para. 73 n.271.

⁶ See § III.C.3 (Qualification to Bid on Market-Based Spectrum Reserve). Additional detailed instructions for electronically filing reverse and forward auction applications, as well as the procedures for submitting forward auction upfront payments, will be provided in separate public notices to be released in the near future. See §§ II.B.3 (Reverse Auction – Qualifying to Bid), III.B.3 (Forward Auction – Requirements for Participation), III.D.4 (Upfront Payments and Bidding Eligibility).

⁷ See Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, §§ 6402 (codified at 47 U.S.C. § 309(j)(8)(G)), 6403 (codified at 47 U.S.C. § 1452), 126 Stat. 156 (2012).

incentive auctions to help meet the Nation's accelerating spectrum needs and requires the Commission to conduct a broadcast television spectrum incentive auction.⁸ The *Incentive Auction R&O* established the framework for Auction 1000, including the 600 MHz Band Plan, the repacking of the broadcast television bands, the incentive auction process, and the post-incentive auction transition. The Commission established final procedures for determining the spectrum clearing target and bidding in the reverse and forward auctions in the *Auction 1000 Bidding Procedures PN*.⁹ This Public Notice, the recent public notice regarding prohibited communications released by the Wireless Telecommunications Bureau ("Bureau"),¹⁰ and the *Auction 1000 Bidding Procedures PN* together establish the final auction procedures for the broadcast incentive auction. In addition to the *Incentive Auction R&O* and these procedures public notices, the Commission has released a number of other decisions in this proceeding regarding the broadcast incentive auction and the repacking process.¹¹

4. The information and deadlines we announce in this Public Notice also implement the Commission's general competitive bidding rules in Part 1, Subpart Q of the Code of Federal Regulations. The Commission made significant changes to the rules applicable to the forward auction in the *Part 1 R&O*.¹² Potential bidders in Auction 1000, particularly those interested in Auction 1002, also should make themselves familiar with the decisions in the *Part 1 R&O*.

II. APPLYING TO PARTICIPATE IN THE REVERSE AUCTION

5. Licensees of commercial and noncommercial educational ("NCE") full power and Class A television stations ("eligible broadcast licensees") identified in the attached Final Baseline may apply to participate in the reverse auction.¹³ On its application, an eligible broadcast licensee will have up to

⁸ See *Incentive Auction R&O*, 29 FCC Rcd at 6569–70, para. 1, 6574, paras. 14–15; *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8980, para. 4.

⁹ See generally *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd 8975.

¹⁰ *Guidance Regarding the Prohibition of Certain Communications During the Incentive Auction, Auction 1000*, AU Docket No. 14-252, GN Docket No. 12-268, WT Docket No. 12-269, Public Notice, DA 15-1129 (rel. Oct. 6, 2015) (*Prohibited Communications PN*).

¹¹ These include decisions regarding channel sharing by eligible broadcast licensees, the market-based spectrum reserve, and inter-service interference. See, e.g., *Innovation in the Broadcast Television Bands: Allocations, Channel Sharing and Improvements to VHF*, ET Docket No. 10-235, Report and Order, 27 FCC Rcd 4616 (2012) (*Channel Sharing Report and Order*); *Mobile Spectrum Holdings R&O*, 29 FCC Rcd 6133; *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions; Office of Engineering and Technology Releases and Seeks Comment on Updated OET-69 Software; Office of Engineering and Technology Seeks to Supplement the Incentive Auction Proceeding Record Regarding Potential Interference Between Broadcast Television and Wireless Services*, GN Docket No. 12-268, ET Docket No. 13-26, ET Docket No. 14-14, Second Report and Order and Further Notice of Proposed Rulemaking, 29 FCC Rcd 13071 (2014) (*ISIX Order and Further Notice*) (modified by Errata (rel. Oct. 24, 2014; Feb. 13, 2015)) (as applicable, we refer below separately to the *ISIX Order* and *ISIX Further Notice*).

¹² *Updating Part 1 Competitive Bidding Rules; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions; Petition of DIRECTV Group, Inc. and EchoStar LLC for Expedited Rulemaking to Amend Section 1.2105(a)(2)(xi) and 1.2106(a) of the Commission's Rules and/or for Interim Conditional Waiver; Implementation of the Commercial Spectrum Enhancement Act and Modernization of the Commission's Competitive Bidding Rules and Procedures*, Docket Nos. WT 14-170, GN 12-268, RM 11395, WT 05-211, Report and Order, Order on Reconsideration of the First Report and Order, Third Order on Reconsideration of the Second Report and Order, and Third Report and Order, 30 FCC Rcd 7493 (2015) (*Part 1 R&O*) (modified by Erratum (rel. Aug. 25, 2015)).

¹³ *Incentive Auction R&O*, 29 FCC Rcd at 6716–17, para. 352–53. Licensees of LPTV and TV translator stations are not eligible to participate in the reverse auction. *Id.* See also *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Second Order on Reconsideration, 30 FCC Rcd 6746, 6811, para. 145 (2015) (*Second Order on Reconsideration*).

three bid options depending on its pre-auction band: (1) go off-air (available to all stations); (2) move to a Low-VHF channel (available to UHF or High-VHF stations); and (3) move to a High-VHF channel (available only to UHF stations).¹⁴ An applicant that intends to relinquish its spectrum usage rights in order to share a channel with a station that will remain on the air following the auction will bid to go off-air.¹⁵

A. Applicable Rules and Disclaimers

1. Relevant Authority

6. Section 6403(a) of the Spectrum Act, codified at 47 U.S.C. § 1452(a), authorizes the reverse auction to determine the amount of compensation that each eligible broadcast licensee would accept in return for voluntarily relinquishing some or all of its broadcast television spectrum usage rights.¹⁶ In the *Incentive Auction R&O*, the Commission adopted rules and policies for the reverse auction. More recently, the Commission developed detailed bidding procedures necessary to govern the reverse auction process in the *Auction 1000 Bidding Procedures PN*.

7. Prospective applicants must familiarize themselves thoroughly with the Commission's competitive bidding rules for the reverse auction.¹⁷ Prospective bidders should also familiarize themselves with the Commission's rules relating to channel sharing, media ownership, post-incentive auction licensing and operation, and rules relating to applications, environmental review, practice and procedure.¹⁸ All bidders must also be thoroughly familiar with the procedures, terms and conditions contained in the *Incentive Auction R&O*, the *Auction 1000 Bidding Procedures PN*, the *Prohibited Communications PN*, this Public Notice, other public notices and/or decisions in this proceeding, and any future public notices and/or decisions that may be issued in this proceeding, as well as any other relevant public notices and/or decisions issued by the Commission relating to the incentive auction.

¹⁴ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9009, para. 50.

¹⁵ See *id.*; see also *Incentive Auction R&O*, 29 FCC Rcd at 6723–30, paras. 365–83; 47 U.S.C. § 1452(a)(2) (providing that options available in the reverse auction shall include a bid to relinquish usage rights in order to share a channel with another licensee).

¹⁶ See 47 U.S.C. § 1452(a)(1).

¹⁷ 47 C.F.R. § 1.2200 *et seq.* As many of the reverse auction pre-auction procedures and application requirements are substantially similar to the Commission's procedures and requirements for typical spectrum license auctions, prospective reverse auction applicants should also familiarize themselves with the Commission's decisions in proceedings regarding its general competitive bidding procedures and application requirements. See 47 C.F.R. Part 1, Subpart Q. See also, e.g., *Amendment of Part 1 of the Commission's Rules – Competitive Bidding Procedures*, WT Docket No. 97-82, Order on Reconsideration of the Third Report and Order, Fifth Report and Order, and Fourth Further Notice of Proposed Rule Making, FCC 00-274, 15 FCC Rcd 15293 (2000) (*Part 1 Fifth R&O*) (modified by Erratum (rel. Nov. 3, 2000)); Seventh Report and Order, FCC 01-270, 16 FCC Rcd 17546 (2001) (*Part 1 Seventh R&O*); Eighth Report and Order, FCC 02-34, 17 FCC Rcd 2962 (2002) (*Part 1 Eighth R&O*); Second Order on Reconsideration of the Third Report and Order and Order on Reconsideration of the Fifth Report and Order, FCC 03-98, 18 FCC Rcd 10180 (2003) (*Part 1 Third R&O Second Recon/Part 1 Fifth R&O Recon*); Second Order on Reconsideration of the Fifth Report and Order, FCC 04-295, 20 FCC Rcd 1942 (2005) (*Part 1 Fifth R&O Second Recon*). See also *Part 1 R&O*, 30 FCC Rcd 7943.

¹⁸ See, e.g., *Channel Sharing Report and Order*, 27 FCC Rcd 4616; *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions; Channel Sharing by Full Power and Class A Stations Outside the Broadcast Television Spectrum Incentive Auction*, GN Docket No. 12-268, MB Docket No. 15-137, First Order on Reconsideration and Notice of Proposed Rulemaking, 30 FCC Rcd 6668, 6671–80, paras. 6–29 (*First Order on Reconsideration*) (modified by Erratum (rel. July 7, 2015) (channel sharing); 47 C.F.R. §§ 73.3555 (Multiple Ownership); 73.3700 (Post-Incentive Auction Licensing and Operation), 1.1307 (environmental review). See also 47 C.F.R. Part 1, Subpart A.

8. The terms contained in the Commission's rules, relevant orders, and public notices are not negotiable. The Commission may amend or supplement the information contained in its public notices at any time, and will issue public notices to convey new or supplemental information to applicants. It is the responsibility of all applicants to remain current with all Commission rules and with all public notices pertaining to this auction. Copies of incentive auction-related Commission documents, including public notices, can be retrieved from the Auction 1000 website at <http://www.fcc.gov/auctions/1000>.¹⁹ Additionally, documents are available at the FCC's headquarters located at 445 12th Street, SW, Washington, DC 20554 during normal business hours.

2. Due Diligence

9. We remind each potential bidder that it is solely responsible for investigating and evaluating all technical and marketplace factors that may have a bearing on the bid(s) it submits in the reverse auction.²⁰ An applicant should perform its due diligence research and analysis before applying to participate in the reverse auction, as it would with any business decision. Each reverse auction bidder in Auction 1001 should continue its research and analysis throughout the auction. In particular, the Bureau strongly encourages each potential bidder to review all Commission orders and public notices establishing rules and policies for the incentive auction. Additionally, each potential bidder should perform technical analyses to assure itself that, should the Commission accept its bid to relinquish spectrum usage rights, the bidder will be able to relocate, build, and operate its facilities, if applicable,²¹ in compliance with all applicable technical and regulatory requirements. The Bureau also strongly encourages each applicant to keep apprised of pending administrative or judicial proceedings, including enforcement proceedings and non-final license validity proceedings or downgrade orders that might affect its decision to offer a particular station in the auction. In addition, applicants should be aware that future administrative or judicial proceedings may affect broadcast television stations generally or individually.

10. The due diligence considerations mentioned in this Public Notice do not comprise an exhaustive list of steps that should be undertaken prior to participating in this auction. As in past spectrum license auctions, the burden is on the potential bidder to determine how much research to undertake, depending upon specific facts and circumstances related to its interests, and to undertake its own assessment of the relevance and importance of information gathered as part of its due diligence efforts. In addition, each reverse auction applicant will be required to acknowledge that it accepts responsibility for its bids and will not attempt to place responsibility for its bids on either the Commission or the information provided by third parties as part of the Commission's extensive outreach and education efforts.²² An auction applicant's failure to include these or any other required

¹⁹ More generally, copies of most auctions-related Commission documents, including public notices, can be retrieved from the FCC Auctions Internet site at <http://www.fcc.gov/auctions>.

²⁰ 47 C.F.R. § 1.2204(c)(7) (requiring a reverse auction applicant to certify that it agrees it has this responsibility).

²¹ Bidders with winning bids to channel share or to move to a High- or Low-VHF channel will continue operating post-auction on new channels.

²² Specifically, the applicant must certify that it "acknowledges and agrees that any information provided by the Commission's outside contractors who are advising and assisting the Commission with education and outreach in connection with the reverse auction is for informational purposes only and that neither the Commission nor any of the Commission's outside contractors makes any representations or warranties with respect to any such information and shall have no liability to the applicant in connection therewith." *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9008, para. 49 n.186. In the *Incentive Auction R&O*, the Commission decided that any applicant seeking to participate in Auction 1001 must certify, under penalty of perjury, that it "agrees that it has the sole responsibility for investigating and evaluating all technical and marketplace factors that may have a bearing on the bids it submits in the reverse auction." 47 C.F.R. § 1.2204(c)(7). Reverse auction applicants must make both due diligence certifications in order for its application to be acceptable for filing.

certifications in its auction application by the applicable filing deadline would render its application unacceptable for filing, and its application would be dismissed with prejudice.

3. Red Light Rule

11. Commission rules, including a provision referred to as the “red light rule,” implement the Commission’s obligation under the Debt Collection Improvement Act of 1996 to aggressively collect debts owed to the Commission.²³ Under the red light rule, the Commission will not process applications and other requests for benefits by parties that owe non-tax debt to the Commission.²⁴ Absent payment or waiver of the red light rule, eligible broadcast licensees that owe debt to the Commission would not be permitted to participate in the reverse auction.

12. Robust broadcaster participation is critical to the success of the incentive auction. Recognizing that, the Commission expressly committed to removing barriers to encourage broadcasters to participate in the reverse auction.²⁵ Consistent with that commitment, in order to encourage broadcaster participation in the reverse auction, we waive the red light rule for the limited purpose of permitting any eligible broadcast licensee that is red lighted for debt owed to the Commission at the time it submits a reverse auction application to participate in the reverse auction, subject to the conditions set forth below. Additionally, we recognize that a reverse auction applicant may incur debt to the Commission after submission of its application, and may fail to pay the debt when due. Accordingly, in order to participate in the auction, each reverse auction applicant will be required to certify in its application that it (1) acknowledges its liability to the Commission for any debt owed to the Commission that the applicant incurred before, or that it may incur after, the reverse auction application deadline, including all accrued interest, penalties and costs, and that the debt will continue to accrue interest, penalties and costs until paid; and (2) agrees that the Commission may pay all debt owed by the applicant to the Commission from the applicant’s share of auction proceeds. As we have noted, this waiver is limited. It does not waive or otherwise affect the Commission’s right or obligation to collect any debt owed to the Commission by an eligible broadcast licensee by any means available to the Commission, including set off, referral of debt to the United States Treasury for collection and/or red lighting other applications or requests for benefits filed by an eligible broadcast licensee.

13. We will also require each reverse auction applicant to certify its agreement that if an appeal of, or request for waiver or compromise of, any debt owed by the applicant to the Commission is pending at the conclusion of the incentive auction, the Commission may withhold so much of the applicant’s share of the auction proceeds as is necessary to pay the debt in full, including accrued interest, penalties and costs, until issuance of a final non-appealable decision regarding the debt or waiver or compromise request, and may then pay the debt from the applicant’s withheld share. Auction funds held to pay such debt will be held in accordance with the provisions of paragraph 48 of this Public Notice.

14. We advise potential applicants to review their own records as well as the Commission’s Red Light Display system to determine whether they owe non-tax debt to the Commission, and to do so periodically during the incentive auction.²⁶ We also encourage eligible broadcast licensees to resolve and

²³ *Amendment of Parts 0 and 1 of the Commission’s Rules; Implementation of the Debt Collection Improvement Act of 1996 and Adoption of Rules Governing Applications or Requests for Benefits by Delinquent Debtors*, MD Docket No. 02-339, Report and Order, 19 FCC Rcd 6540 (2004) (implementing Pub. L. No. 104-134, 110 Stat. 1321, 1358 (1996) (*Debt Collection Report and Order*); 47 C.F.R. Part 1, Subpart O.

²⁴ 47 C.F.R. § 1.1910(b)(2).

²⁵ *Incentive Auction R&O*, 29 FCC Rcd at 6570, para. 2. See also *id.* at 6720–22, paras. 359–61 (allowing broadcasters with pending enforcement matters or license renewal applications that raise enforcement issues to participate in the reverse auction under specified conditions in order to facilitate broadcaster participation).

²⁶ The Commission’s Red Light Display system is accessible online at <https://apps.fcc.gov/redlight/login.cfm>.

pay all outstanding debts to the Commission as soon as possible to avoid the accrual of interest, penalties and costs on unpaid debt.

4. Use of Auction System

15. Bidders will be able to participate in Auction 1001 over the Internet using the Commission's bidding system ("Auction System"). The Commission makes no warranty whatsoever with respect to the Auction System. In no event shall the Commission, or any of its officers, employees, or agents, be liable for any damages whatsoever (including, but not limited to, loss of business profits, business interruption, loss of business information, or any other loss) arising out of or relating to the existence, furnishing, functioning, or use of the Auction System. Moreover, no obligation or liability will arise out of the Commission's technical, programming, or other advice or service provided in connection with the Auction System.

5. Fraud Alert

16. As is the case with many business opportunities, some unscrupulous parties may attempt to use Auction 1001 to deceive and defraud unsuspecting eligible broadcast licensees. **Every eligible broadcast licensee is responsible for monitoring whether any applications have been filed for its license(s) in order to assure that only authorized applications are filed.** All licensees of eligible facilities recently completed a Form 2100 Schedule 381 Pre-Auction Technical Certification for each eligible facility using the Commission's new Licensing and Management System ("LMS"). At that time, if that licensee had more than one FCC Registration Number ("FRN") associated with the eligible facility, LMS required the licensee to choose one FRN and one related password to associate with that facility. **Individuals in possession of this FRN and the related password will be able to file an application to participate in the reverse auction on behalf of the licensee. Therefore, we urge all licensees to maintain the integrity of their FRN and related password by regularly changing their password, and to monitor the auction filing system to assure that no unauthorized filings are made.**²⁷ Licensees that become aware of an unauthorized filing should notify the Commission immediately in writing by e-mail to auction1001@fcc.gov.

B. Auction Specifics

1. Auction Title and Start Date

17. The reverse portion of the incentive auction will be referred to as "Auction 1001 – Broadcast Television Spectrum Incentive Reverse Auction." The incentive auction will begin on March 29, 2016, with the deadline for reverse auction applicants to commit to an initial bid option in Auction 1001. Dates and deadlines for the reverse auction are listed below.

18. Reverse auction bidders will be informed of the initial schedule of bidding rounds, including the time each round will start and finish and the number of rounds per day, when they are informed that they are qualified to bid.²⁸

2. Auction 1001 Dates and Deadlines

19. The following dates and deadlines apply:

Pre-Auction Process Tutorial Available (via Internet).....November 17, 2015

FCC Form 177 Filing Window Opens ("ET")December 1, 2015; 12:00 noon Eastern Time

²⁷ Because we will keep the identity of all reverse auction participants confidential, the licensee must review the auction filing system to become aware of fraudulent or unauthorized reverse auction filings rather than relying on review of a publicly released list of participants.

²⁸ *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9028–29, para. 96; *Incentive Auction R&O*, 29 FCC Rcd at 6755, para. 453.

FCC Form 177 Filing Window Deadline.....	December 18, 2015; 6:00 p.m. ET
Bidding and Post-Auction Process Tutorial Available (via Internet)	February 29, 2016
Initial Commitment Deadline	March 29, 2016; 6:00 p.m. ET
Initial Clearing Target and Band Plan Announced	Three to four weeks after the initial commitment deadline
Mock Auction(s)	Specific date to be provided to each applicant that is qualified to bid by confidential status letter after the initial clearing target is announced ²⁹
Bidding in the Clock Rounds Begins.....	Specific date to be provided to each applicant that is qualified to bid by confidential status letter after the initial clearing target is announced

3. Requirements for Qualifying to Bid

20. Eligible broadcast licensees wishing to qualify to bid in the clock rounds of Auction 1001 must:

- Submit an auction application (FCC Form 177) electronically prior to 6:00 p.m. ET, on December 18, 2015, following the electronic filing instructions that will be provided in a separate public notice to be released in the near future (“FCC Form 177 Instructions”);
- Make an initial commitment prior to 6:00 p.m. ET, on March 29, 2016, following the procedures and instructions that will be set forth in the FCC Form 177 Instructions; and
- Comply with all provisions outlined in this Public Notice, the *Auction 1000 Bidding Procedures PN*, the *Incentive Auction R&O*, and applicable Commission rules and policies.

4. Auction Delay, Suspension, or Cancellation

21. By public notice or by announcement during the reverse auction, the auction may be delayed, suspended, or cancelled in the event of a natural disaster, technical obstacle, network disruption, evidence of an auction security breach or unlawful bidding activity, administrative or weather necessity, or for any other reason that affects the fair and efficient conduct of the competitive bidding.³⁰ In such cases, the Bureau, in its sole discretion, may elect to resume the competitive bidding starting from the beginning of the current or from some previous round or cancel the competitive bidding in its entirety. We emphasize that we will exercise this authority solely at our discretion.

C. Reverse Auction Application (FCC Form 177)

22. The applicant to participate in the reverse auction (Auction 1001) must be the broadcast television licensee that holds the spectrum usage rights being offered for relinquishment.³¹ A licensee that

²⁹ Each bidder qualified to bid in the clock rounds will have an opportunity to participate in at least one mock auction. As discussed in more detail below, we anticipate that we will need to conduct at least two mock auctions to accommodate the large number of broadcasters that we expect will qualify to bid in the clock rounds of the reverse auction.

³⁰ See 47 C.F.R. § 1.2203(d).

³¹ See *id.* § 1.2204(b). Thus, for example, a holding company cannot be an applicant instead of the actual licensed entity.

holds licenses for multiple eligible stations that it wishes to offer in the auction may include all of its eligible stations in a single application, as long as it identifies each such station and provides the required information for each. The application to participate in Auction 1001 is referred to as FCC Form 177 and provides information used to determine whether the applicant is legally qualified to participate in the reverse auction to relinquish some or all of its spectrum usage rights in exchange for a portion of the incentive auction proceeds.³² Submitting an FCC Form 177 is the first of two steps in the Commission's process to qualify to bid in the reverse auction.³³

23. Each licensee seeking to relinquish spectrum usage rights in Auction 1001 must file an auction application electronically via the Auction System prior to 6:00 p.m. ET on December 18, 2015, following the procedures that will be provided in the FCC Form 177 Instructions.³⁴ All eligible broadcast licensees, including reverse auction applicants, are subject to the Commission's rules prohibiting certain communications beginning at the deadline for filing.³⁵

24. Applicants bear full responsibility for submitting accurate, complete and timely reverse auction applications.³⁶ Each applicant must make a series of certifications under penalty of perjury on its FCC Form 177 related to the information provided in its application and its participation in the auction, and must confirm that it is in compliance with all statutory and regulatory requirements for participation in the reverse auction, including any requirements with respect to stations identified in the auction application.³⁷

25. An applicant submitting an application in Auction 1001 to relinquish spectrum usage rights for a Class A or NCE television station must submit additional information about the relevant license. Specifically, if the license is for a Class A television station, the applicant must certify under penalty of perjury that it is and will remain in compliance with the ongoing statutory eligibility requirements to remain a Class A station.³⁸ If the license is for an NCE station, the applicant must specify whether it operates on a reserved or non-reserved channel.³⁹

26. The submission of an FCC Form 177 (and any amendments thereto) constitutes a representation by the individual certifying the application that he or she is authorized to do so on behalf of the applicant,⁴⁰ that he or she has read the form's instructions and certifications, and that the contents of

³² See *id.* § 1.2204.

³³ In the second step, if the applicant's FCC Form 177 is timely-filed and deemed complete, it must then commit, at the associated opening price, to a preferred relinquishment option for each station for which it wishes to place bids in the clock rounds. See § II.D.4 (Initial Commitment). See also *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9011-22, paras. 54-72.

³⁴ See 47 C.F.R. § 1.2204(a).

³⁵ See *id.* § 1.2205. See also *Prohibited Communications PN* at 1-2, para. 2.

³⁶ An applicant's auction application may contain some pre-filled information such as an applicant's facility identification number, call sign, and Designated Market Area. Each applicant must carefully review any information automatically entered in its FCC Form 177 to confirm that all information supplied on the application is complete and accurate as of the application filing deadline.

³⁷ See 47 C.F.R. § 1.2204(c)(10).

³⁸ See *id.* § 1.2204(c)(3)(iii).

³⁹ See *id.* § 1.2204(c)(3)(iv).

⁴⁰ See *id.* § 1.2204(c)(9). If the individual certifying the FCC Form 177 is not an officer, director, board member, or controlling interest holder of the applicant, the applicant must be able to provide evidence that such individual has the authority to bind the applicant. *Id.*

the application, its certifications, and any attachments are true and correct.⁴¹ Submission of any false certification(s) to the Commission may result in penalties, including monetary forfeitures, license forfeitures, denial or dismissal of applications with respect to Auction 1001, ineligibility to participate in future auctions, and/or criminal prosecution.

27. Below we discuss additional details regarding certain information required to be submitted in the FCC Form 177. However, each applicant should read carefully the forthcoming FCC Form 177 Instructions and consult the Commission's rules to ensure that, in addition to the materials described below, all the information required to be submitted in an auction application is included within its application.⁴²

1. Authorized Bidders

28. As part of the auction application, the applicant must identify at least one, but no more than three, person(s) authorized to place bids in the auction.⁴³ The individual submitting the application must certify that the applicant agrees that any bid submitted is an irrevocable, binding offer by the applicant to relinquish the relevant spectrum usage rights at the offered price⁴⁴

2. Identifying Relinquishment Bid Option(s) for Each Eligible Facility

29. *Background.* Eligible broadcast licensees may bid to voluntarily relinquish the spectrum usage rights associated with station facilities identified in the attached Final Baseline.⁴⁵ A station may be included in the Final Baseline notwithstanding that its license has been cancelled, has expired, is subject to a revocation order (collectively, a "license validity proceeding") or, for a Class A station, is subject to a downgrade order. Such a station will no longer be eligible to be offered for relinquishment in the

⁴¹ As discussed in § II.C.7 (Modifications to FCC Form 177), applicants are not permitted to make major modifications to their applications after the filing deadline. Changes to any of the required certifications, including a change in the official certifying the application, is considered a major change and would therefore not be permitted.

⁴² As noted above, the FCC Form 177 electronic filing procedures will be provided in a separate public notice to be released in the near future.

⁴³ See 47 C.F.R. § 1.2204(c)(2). There may be circumstances in which reverse auction applicants might share the same authorized bidder. See, e.g., *Prohibited Communications PN* at 9, para. 20.

⁴⁴ See 47 C.F.R. § 1.2204(c)(8); see also *id.* § 1.2203(b) ("A bid is an unconditional, irrevocable offer by the bidder to fulfill the terms of the bid. The Commission accepts the offer by identifying the bid as winning. A bidder has a binding obligation to fulfill the terms of a winning bid. A winning bidder will relinquish spectrum usage rights pursuant to the terms of any winning bid by the [applicable] deadline . . .").

⁴⁵ See Attachment 2, Appendix I (Final Baseline). The facilities in the Final Baseline are those that were licensed by May 29, 2015 (the "Pre Auction Licensing Deadline"), that received a waiver of that licensing deadline, that were explicitly excepted from that deadline (such as those stations impacted by the destruction of the World Trade Center), and those for which the Media Bureau granted a Petition for Eligible Entity Status. See *Media Bureau Announces Incentive Auction Eligible Facilities and July 9, 2015 Deadline for Filing Pre-Auction Technical Certification Form*, Public Notice, 30 FCC Rcd 6153 (2015) (establishing a preliminary list of eligible facilities and a procedure for requesting eligible station status for facilities excluded from list); *Incentive Auction R&O*, 29 FCC Rcd at 6718, para. 355 (requiring, with limited exception, a facility to be licensed or have on file a license to cover by the Pre-Auction Licensing Deadline in order to be eligible for voluntarily relinquishment in the reverse auction); *id.* at 6719 n.1057 (establishing a Pre-Auction Licensing Deadline exception for certain stations affected by the destruction of the World Trade Center); *Second Order on Reconsideration*, 30 FCC Rcd at 6769, para. 53 (extending protection to Class A stations that had an application for a Class A construction permit pending or granted as of February 22, 2012); *id.* at 6763 para. 41 (extending World Trade Center exception to WNJU, Linden, NJ); *Media Bureau Designates May 29, 2015 as Pre-Auction Licensing Deadline*, Public Notice, 30 FCC Rcd 393 (2015) (designating May 29, 2015 as the Pre-Auction Licensing Deadline by which full power and Class A facilities must be licensed or have on file a license to cover application in order for that facility to be eligible for relinquishment in the reverse auction).

reverse auction, however, if that license validity proceeding or downgrade becomes final and non-reviewable by December 18, 2015.⁴⁶ As discussed in more detail below, an eligible broadcast licensee may offer to relinquish the spectrum usage rights associated with a station subject to a license validity proceeding or Class A downgrade order that has not become final and non-reviewable by that deadline subject to certain conditions.⁴⁷

30. *Application Procedures.* For each station that the applicant includes on its application,⁴⁸ the applicant must identify one or more bid options, corresponding to the relinquishment options that the applicant wishes to be able to consider for that station in the reverse auction.⁴⁹ The bid options are described above in paragraph 5 and in more detail in the *Auction 1000 Bidding Procedures PN*.⁵⁰

31. An applicant has no obligation to bid for the options it identifies in its application; if the applicant plans to bid in the clock rounds, it will need to commit to one of its identified bid options prior to the deadline to submit an initial commitment. However, an applicant should take care when selecting bid options in its auction application. As determined in the *Auction 1000 Bidding Procedures PN*, if an applicant does not identify a particular bid option for a specific station on its auction application, that applicant will not be able to bid for that option for that station, either in making its initial commitment or in the clock bidding rounds.⁵¹ An applicant wishing to preserve flexibility to bid for all options in the auction should select all options available to each station.⁵²

3. Ownership Disclosure Requirements

32. Each applicant must comply with the applicable Part 1 ownership disclosure standards and provide information required by sections 1.2204 and 1.2112(a) of the Commission's rules.⁵³ Specifically, in completing the FCC Form 177, an applicant will be required to fully disclose information on the real party- or parties-in-interest and the ownership structure of the applicant, including both direct and indirect ownership interests of 10 percent or more, as prescribed in section 1.2112.⁵⁴ Each applicant is responsible for ensuring that information submitted in its application is complete and accurate.

33. In certain circumstances, an applicant's most current ownership information on file with the Commission, if in an electronic format compatible with the FCC Form 177 (such as information submitted in an FCC Form 175 filed from a previous auction) will automatically be entered into the applicant's auction application. Each applicant must carefully review any information automatically

⁴⁶ *Incentive Auction R&O*, 29 FCC Rcd at 6722–23, para. 363 & n. 1078. If the license invalidity determination or downgrade becomes final and non-reviewable prior to the auction application deadline, the licensee will not be permitted to submit an application for the subject station.

⁴⁷ See § II.C.6 (Provisions Regarding Pending Proceedings).

⁴⁸ The FCC Form 177 Instructions will provide further instruction on how an applicant will select which station(s) it would like to offer to relinquish in the reverse auction.

⁴⁹ 47 C.F.R. § 1.2204(c)(3)(v); see also *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9008–09, para. 49.

⁵⁰ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9009–10, paras. 50–51; *Incentive Auction R&O*, 29 FCC Rcd at 6723, para. 365; *id.* at 6730, para. 380.

⁵¹ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9008–09, para. 49.

⁵² See *id.* at 9010, para. 52 n. 200.

⁵³ 47 C.F.R. § 1.2204(c) (providing that “[a]n applicant may be required to provide the following information in its application to participate in the reverse auction: . . . [a]pplicant ownership and other information as set forth in 1.2112(a)”).

⁵⁴ See *id.* § 1.2112.

entered in its FCC Form 177 to confirm that all information supplied on the application is complete and accurate as of the application filing deadline.⁵⁵

34. Among other information, applicants must supply identifying information about the applicant, including the applicant's name and address, if the applicant is an individual; the name and address of the corporate office and the name and title of an officer or director if the applicant is a corporation; the name, citizenship, and address of all general partners, and, if a general partner is not a natural person, then the name and title of a responsible person for that partner, if the applicant is a partnership; the name and address of the trustee, if the applicant is a trust; and if the applicant is none of the above, it must identify and describe itself and its principals or other responsible persons.⁵⁶ Additionally, for non-profit entities, applicants must list the name, address, and citizenship of each member of the governing board and of any educational institution or governmental entity with a controlling interest in the applicant, if applicable.⁵⁷

4. National Security Certification

35. Section 6004 of the Spectrum Act, codified at 47 U.S.C. § 1404, prohibits a person who has been, for reasons of national security, barred by any agency of the Federal Government from bidding on a contract, participating in an auction, or receiving a grant from participating in any auction that is required or authorized to be conducted pursuant to the Spectrum Act.⁵⁸ In the *Incentive Auction R&O*,⁵⁹ the Commission adopted a rule to implement this mandate by adding a certification to the various other certifications that a reverse auction applicant must make in its application.⁶⁰ Pursuant to this rule, any applicant seeking to participate in Auction 1001 must certify in its FCC Form 177, under penalty of perjury, that the applicant and all of the related individuals and entities required to be disclosed on its application are not person(s) who have been, for reasons of national security, barred by any agency of the Federal Government from bidding on a contract, participating in an auction, or receiving a grant, and who are thus statutorily prohibited from participating in such a Commission auction.⁶¹

5. Additional Information and Certifications Required From Applicants Intending to Channel Share

36. *Background.* The Commission adopted rules and procedures concerning channel sharing arrangements in the *Channel Sharing R&O*,⁶² the *Incentive Auction R&O*,⁶³ and the *First Order on Reconsideration*.⁶⁴ An eligible broadcast licensee interested in entering into a channel sharing

⁵⁵ FCC Form 323 is not compatible with FCC Form 177; therefore, information provided to the Commission on that form will not be automatically entered into an applicant's auction application.

⁵⁶ See 47 C.F.R. § 1.2204(c)(1)(i).

⁵⁷ See *id.* § 1.2204(c)(1)(iii).

⁵⁸ See 47 U.S.C. § 1404.

⁵⁹ *Incentive Auction R&O*, 29 FCC Rcd at 6750, para. 439.

⁶⁰ See 47 C.F.R. § 1.2204(c)(6).

⁶¹ *Id.*

⁶² See generally *Channel Sharing Report and Order*, 27 FCC Rcd 4616.

⁶³ See, e.g., *Incentive Auction R&O*, 29 FCC Rcd at 6727–29, paras. 374–78, 6744, para. 418, 6746–47, para. 428, 6748–49, paras. 436–37, 6795–96, para. 558, 6852–60, paras. 699–711.

⁶⁴ See generally *First Order on Reconsideration*, 30 FCC Rcd at 6671–80, paras. 6–29.

arrangement should familiarize itself with those orders and the requirements adopted therein, as well as any future orders or public notices concerning channel sharing.⁶⁵

37. Under the Commission's rules, a reverse auction bidder that is interested in relinquishing its spectrum usage rights on its current channel in order to share another licensee's channel following the auction, and that has entered into a channel sharing agreement ("CSA") before the reverse auction application filing deadline ("pre-auction CSA"), must submit an executed copy of the CSA with its auction application.⁶⁶ Applicants who have entered into a pre-auction CSA must also make several certifications under penalty of perjury, as described below.⁶⁷ The rules also provide that an applicant that executes a pre-auction CSA and submits a copy of the executed agreement with its auction application will be covered under a limited exception to the rule prohibiting communications regarding bids and bidding strategies during the period defined by the rule.⁶⁸ This exception will allow the applicant to discuss bids and bidding strategies with the other party or parties to the pre-auction CSA to the extent covered by this exception, subject to the limitations outlined in the *Prohibited Communications PN*.⁶⁹

38. Additionally the Commission's rules allow winning reverse auction bidders that relinquish their spectrum usage rights in the reverse auction to enter into CSAs after the completion of the incentive auction ("post-auction CSAs"), provided that they (1) indicate in their pre-auction applications that they have a present intent to find a channel sharing partner after the auction,⁷⁰ and (2) execute and implement their post-auction CSAs by the date on which they would otherwise be required to relinquish their licenses.⁷¹ The channel sharing exception to the rule prohibiting certain

⁶⁵ The Commission is not the guarantor or enforcer of any channel sharing agreement ("CSA"). See *Auction 1000 Comment PN*, 29 FCC Rcd at 15777, para. 75. The Public Broadcasting Service, Association of Public Television Stations, and Corporation for Public Broadcasting (collectively, "PTV") express concern that this suggests the Commission could seek to enforce its rules against an entirely innocent party whose violation of the Commission's regulations results solely from another's breach of the CSA. PTV Comments at 10. PTV's concern and its related comments are outside the scope of this Public Notice. See *Incentive Auction R&O*, 29 FCC Rcd at 6852, para. 699 n.1944 ("We do not anticipate being involved in any disputes between channel sharing stations to the extent that such disputes are not directly related to compliance with the Communications Act or applicable Commission policies and rules. We expect that any disputes concerning the terms and conditions of the CSA, including those that are directly related to compliance with the Communications Act or our rules, would be handled in the first instance by the channel sharing stations as a private contractual enforcement matter and that we would independently determine if additional regulatory enforcement steps would be warranted.").

⁶⁶ *Incentive Auction R&O*, 29 FCC Rcd at 6748–49, para. 436. The applicant relinquishing spectrum is known as the "sharee" and the station whose channel will host the sharee is known as the "sharer."

⁶⁷ *Id.* at 6727–28, para. 376, 6748–49, para. 436; 47 C.F.R. § 1.2204(c)(5).

⁶⁸ 47 C.F.R. § 1.2205(b)(2)(iii).

⁶⁹ See *Prohibited Communications PN* at 2, para. 4, 8–9, paras. 18–20. As discussed in the *Prohibited Communications PN*, applicants may choose not to avail themselves of the exception in order to protect against rule violations. *Id.* at 9, para. 20 n.36. Applicants will be able to provide information with their applications regarding relevant firewalls or other safeguards established to protect against rule violations, although there is no requirement that they do so. *Id.* at 7, para. 15 n.29. Applicants may upload such information in attachments to their applications. *Id.*

⁷⁰ The expression of present intent will not bind an applicant to seek out a channel sharing partner or enter into a post-auction CSA.

⁷¹ See *First Order on Reconsideration*, 30 FCC Rcd at 6673, para. 13. As the Commission has explained, a winning bidder that relinquishes its spectrum usage rights and enters into a post-auction CSA will have the same post-auction MVPD carriage rights as parties to pre-auction CSAs provided that the winning bidder indicates an intent to enter into a post-auction CSA on its FCC Form 177. *Id.*

communications will not cover applicants that indicate their present intent to enter into a post-auction CSA and do not submit a pre-auction CSA.⁷²

39. *Application Requirements.* A channel “sharee” applicant that intends to relinquish spectrum usage rights in order to share another station’s channel post-auction will be required to indicate on its auction application whether it has entered into a CSA prior to the reverse auction application filing deadline, and/or has a present intent to enter into a CSA after the conclusion of the incentive auction and release of the *Channel Reassignment Public Notice* (“*Channel Reassignment PN*”).⁷³ An applicant that indicates it has entered into a pre-auction CSA must identify on its auction application the parties to the CSA, including the sharer or host station, any other sharee(s), and the television channel the applicant has agreed to share.⁷⁴ An applicant that submits an executed CSA may also express an intention to enter into a CSA after the conclusion of the incentive auction. Doing so could allow the licensee to seek a different channel sharing partner following the auction.

40. An applicant submitting a copy of an executed CSA with its auction application should not redact any portion of the agreement.⁷⁵ Unless required by law, the Commission will keep the copy of the executed CSA submitted with the auction application from being made public, even if such an applicant becomes a winning bidder.⁷⁶ Winning reverse auction channel sharing bidders will be required to include a copy of their CSA with their post-auction construction permit application (LMS Form 2100-Schedules A and E), which will be publicly available, and we will allow applicants to redact confidential or proprietary terms for the purposes of that submission.⁷⁷

a. Channel Sharing Certifications

41. An applicant with a pre-auction CSA will be required to certify under penalty of perjury that: (1) the CSA is consistent with all Commission rules and policies, and that the applicant accepts any risk that the implementation of the CSA may not be feasible for any reason, including any conflict with requirements for operation on the shared channel;⁷⁸ (2) the proposed channel sharing arrangement will not trigger a new combination that violates the multiple ownership rules, set forth in section 73.3555 of

⁷² The exception to the rule prohibiting certain communications will apply only to the parties to a pre-auction CSA that is submitted by the application filing deadline. *First Order on Reconsideration*, 30 FCC Rcd at 6673, para. 13. See also *Incentive Auction R&O*, 29 FCC Rcd at 6740, para. 406 (“the exception to the prohibition for parties to a [CSA] will apply only if the agreement has been executed prior to the reverse auction application filing deadline and has been disclosed on the application.”).

⁷³ Applicants that select the post-auction CSA option must execute and implement their CSAs by the date on which they would otherwise be required to relinquish their licenses. See *First Order on Reconsideration*, 30 FCC Rcd at 6673, para. 13.

⁷⁴ See 47 C.F.R. § 1.2204(c)(5)(i). We note that a sharer station may be reassigned a new channel during the repacking process. See *Incentive Auction R&O*, 29 FCC Rcd at 6746, para. 428 n. 1246.

⁷⁵ See *Incentive Auction R&O*, 29 FCC Rcd at 6852, para. 699 n.1945 (noting that “[a]s with any document filed with the Commission, parties may seek confidential treatment”).

⁷⁶ See 47 C.F.R. § 0.459(f) (“[The Commission] may determine on its own motion that the materials should be withheld from public inspection.”). Understanding that many applicants may include proprietary terms in their CSAs, given the limited amount of time available to conduct application review and process any confidentiality requests, and because winning bidders will ultimately need to resubmit their CSAs, we find that maintaining the confidentiality of CSAs submitted for the purposes of applying to bid in the reverse auction to be reasonable as we expect information provided in CSAs to be the type of materials not routinely available for public inspection. See *id.* §§ 0.457(d); 1.2206.

⁷⁷ See 47 C.F.R. § 73.3700(b)(1)(vii); see also *First Order on Reconsideration*, 30 FCC Rcd at 6679, para. 28 n.88.

⁷⁸ See 47 C.F.R. § 1.2204(c)(5)(iii).

the Commission's rules, based on facts at the time the application is submitted;⁷⁹ (3) its operation from the shared channel facilities will not result in a change to its Designated Market Area;⁸⁰ and (4) it can meet the community of license coverage requirement set forth in section 73.625(a) from the shared channel facilities or, if not, that the new community of license for its shared channel facilities either meets the same or a higher allotment priority as its current community; or, if no community meets the same or higher allotment priority, provides the next highest priority.⁸¹

42. A prospective sharer station under a pre-auction CSA need not submit an application to participate in the reverse auction unless it intends to participate in bidding to offer some or all of its spectrum usage rights for relinquishment.⁸² However, it must make the first two certifications listed in the immediately preceding paragraph.⁸³ Additionally, if the sharer is a Class A station it must certify under penalty of perjury that it is and will remain in compliance with the ongoing statutory eligibility requirements to remain a Class A station.⁸⁴ Also, a sharer station must certify that the CSA submitted by the reverse auction applicant is a true, correct, and complete copy of the CSA between the parties.⁸⁵ The FCC Form 177 Instructions will provide a form with the required certifications that a sharer must sign and give to the sharee(s) to upload into the sharee(s)'s auction application.

43. The channel sharing certifications must be made by persons authorized to bind the sharee and sharer, respectively. We note that the person who makes the channel sharing certifications for the sharee may be a different person than the person who makes all other required certifications in the sharee's reverse auction application.

6. Provisions Regarding Pending Proceedings

44. *Background.* The Commission determined that eligible broadcast licensees with pending enforcement matters or license renewal applications that raise enforcement issues whose bids may result in their holding no broadcast licenses,⁸⁶ as well as eligible broadcast licensees of facilities subject to a non-final license validity proceeding or downgrade order,⁸⁷ may participate in the reverse auction subject to any incentive payment being held until the pending proceedings are finally resolved. This section

⁷⁹ See *id.* § 1.2204(c)(5)(vi). Regardless of whether an arrangement is entered into pre- or post-auction, a sharee must include a showing of compliance with the multiple ownership rules in its construction permit application if operation from the shared site triggers a new multiple ownership combination that is subject to those rules. For pre-auction arrangements, the showing must be based on the facts at the time the sharee filed its application to participate in the reverse auction. For post-auction arrangements, the showing must be based on the facts as of the filing of the construction permit application.

⁸⁰ See *id.* § 1.2204(c)(5)(iv).

⁸¹ See *id.* § 1.2204(c)(5)(v).

⁸² See *Incentive Auction R&O*, 29 FCC Rcd at 6746, para. 428. Examples of this would be where a sharer with a UHF channel bids to move to the VHF band, or a CSA in which the sharee is defined as the party that becomes the provisionally winning station first during the bidding rounds.

⁸³ See 47 C.F.R. § 1.2204(c)(5)(vii). See also *id.* § 1.2204(c)(5)(iii) and (vi).

⁸⁴ *Id.* § 1.2204(c)(3)(iii), (c)(5)(vii).

⁸⁵ The Commission sought comment on this sharer certification in the *Auction 1000 Comment PN*. 29 FCC Rcd at 15778, para. 81. No commenter addressed this specific issue.

⁸⁶ See *Incentive Auction R&O*, 29 FCC Rcd at 6720–21, para. 359. An applicant that will continue to hold at least one broadcast license upon acceptance of its bids will remain subject to any pending license renewal, as well as any enforcement action against the station offered at auction. Auction applicants will be required to acknowledge this continuing liability in their Form 177. *Incentive Auction R&O*, 29 FCC Rcd at 6720, para. 359 n.1067.

⁸⁷ See *id.* at 6722, para. 363. This treatment will apply to the facilities of full power and Class A licensees with expired, cancelled, or revoked licenses, and to the facilities of licensees that have been downgraded from Class A to LPTV status. See *id.* at 6667, para. 225.

describes the additional information that such licensees must provide on their reverse auction applications and the process by which the Commission will hold their incentive payments pending resolution of these types of proceedings.

45. *Application Procedures.* Each applicant that selects going off-air as a bidding option for a station must indicate on its auction application whether or not it will hold any other broadcast licenses in the event that all of the bids that it might place to go off-air are accepted. If it will hold another broadcast license in such an event, then the applicant must certify that the applicant will remain subject to any license renewal, as well as any enforcement action, pending at the time of the auction application deadline against the station that may go off-air as a result of the auction.⁸⁸ If it will not hold any other broadcast licenses in such an event, then the applicant must certify its agreement (1) that pursuant to the Commission's announced procedures for resolving such matters in connection with this auction, the Commission may withhold a portion of the share of auction proceeds for the station, if any, pending final determination of any FCC liabilities with respect to the station and such portion may be applied towards the satisfaction of such liabilities;⁸⁹ and (2) that the applicant remains subject to the Commission's jurisdiction and authority to impose enforcement or other FCC liabilities with respect to the station, notwithstanding the surrender of its license for the station.⁹⁰

46. Each applicant must also indicate for each license identified in its application whether the license is subject: (1) to a non-final revocation order; or (2) has expired or been cancelled and is subject to a non-final license cancellation order.⁹¹ Likewise, an applicant that includes a Class A television station in its application must indicate whether that station is subject to a non-final downgrade order.⁹² An applicant that indicates that a license in its application is subject to any of the foregoing revocation, cancellation, or downgrade proceedings must certify in its application that it agrees with the Commission's announced procedures to withhold all of any incentive payment for the station pending the final outcome of the proceeding.

47. In the confidential letter informing an applicant of the initial status of its auction application, the Wireless Telecommunications and Media Bureaus (collectively, the "Bureaus") will inform the applicant of any potential FCC liabilities with respect to a particular station that cannot be resolved before the initial commitment deadline. In addition, the Bureaus will indicate the amount of auction proceeds that the Commission will withhold should the applicant relinquish its license(s) as a result of the auction and therefore otherwise no longer be subject to the Commission's jurisdiction. The amount withheld will represent the maximum necessary to cover a potential forfeiture based on enforcement matters existing at that time.⁹³ This process ensures that the applicant will be aware of any withholding before making an initial commitment to relinquish its spectrum usage rights. The applicant's certifications ensure that an applicant whose stations may go off-air as a result of the auction will not thereby avoid any liability to the public and owed to the Commission.

48. All auction proceeds held (i) to cover potential enforcement liabilities, (ii) because of an ongoing license validity or downgrade proceeding, or (iii) until final resolution of an appeal of a debt determination or a compromise or waiver request will be held by the Commission in the U.S. Treasury.

⁸⁸ See 47 C.F.R. § 1.2204(c)(4)(ii).

⁸⁹ See *id.* § 1.2204(c)(4)(iii).

⁹⁰ See *Auction 1000 Comment PN*, 29 FCC Rcd at 15778–79, para. 82.

⁹¹ If such an order becomes final and non-reviewable before the deadline for filing, the former licensee is not eligible to participate.

⁹² If such a downgrade order becomes final before the deadline for filing, the licensee is no longer eligible to participate.

⁹³ *Incentive Auction R&O*, 29 FCC Rcd at 6721–22, para. 361. See also *Auction 1000 Comment PN*, 29 FCC Rcd at 15780, para. 85.

As determined by the Commission in the *Incentive Auction R&O*, amounts held following the auction will be released to the broadcaster or applied towards any forfeiture costs and other debt the broadcaster owes to the Commission, as appropriate in light of the final resolution of the relevant issues.⁹⁴ This procedure is consistent with the Commission's reverse auction competitive bidding rules⁹⁵ and with its proposal in the *Auction 1000 Comment PN* that auction proceeds be held in the U.S. Treasury pending resolution of outstanding enforcement proceedings, license renewal proceedings, or other potential eligibility impediments.⁹⁶

7. Modifications to FCC Form 177

a. Only Minor Modifications Allowed

49. After the initial FCC Form 177 filing deadline, an Auction 1001 applicant will be permitted to make only minor changes to its application.⁹⁷ Examples of minor changes include the deletion or addition of authorized bidders (to a maximum of three), revision of addresses and telephone numbers of the applicant, its responsible party, and its contact person, and change in the applicant's selected bidding preference (electronic or telephonic). Major modification to an FCC Form 177 (e.g., add or remove a license identified for relinquishment, change of relinquishment option for a particular license, certain changes in ownership that would constitute an assignment or transfer of control of the applicant,⁹⁸ change any of the required certifications, change the certifying official, add a new CSA or change a party to a CSA, change in applicant's legal classification that results in a change in control) will not be permitted after the initial FCC Form 177 filing deadline.⁹⁹ If an amendment reporting changes is a "major amendment," as defined in section 1.2204(d)(3), the major amendment will not be accepted and may result in the dismissal of the application.

b. Duty to Maintain Accuracy and Completeness of FCC Form 177

50. Pursuant to sections 1.65 and 1.2204(d)(5) of the Commission's rules, each applicant has a continuing obligation to maintain the accuracy and completeness of information furnished in a pending application, including a pending application to participate in the reverse auction.¹⁰⁰ An Auction 1001

⁹⁴ See *Incentive Auction R&O*, 29 FCC Rcd at 6721–22, para. 361. As discussed in the *Incentive Auction R&O*, the Commission will hold some or all of a reverse auction winning bidder's incentive payment until: (1) the later of (i) two years after the date on which the licensee relinquishes the station's license, or (ii) after the resolution of a complaint filed to collect a forfeiture; or (2) when all of the held funds are distributed. *Id.* To the extent necessary, an applicant's agreement with the Commission to hold its share of auction proceeds will extend the Statute of Limitations applicable to the Commission and to collection actions by the Department of Justice. See 47 U.S.C. § 503(b)(6); 28 U.S.C. § 2462; *Incentive Auction R&O*, 29 FCC Rcd at 6721, para. 361 n. 1071. See also § II.A.3 (Red Light Rule).

⁹⁵ See 47 C.F.R. § 1.2204(c)(3)(vi), (c)(4).

⁹⁶ See *Auction 1000 Comment PN*, 29 FCC Rcd at 15778–79, para. 82. We received no comment on this proposal.

⁹⁷ See 47 C.F.R. § 1.2204(d)(3). Minor amendments include any changes that are not major, such as correcting typographical errors and supplying or correcting information as requested to support the certifications made in the application.

⁹⁸ In the *Prohibited Communications PN*, the Wireless Telecommunications Bureau *sua sponte* waived the bar on assignments of licenses that are the subject of an auction application, or transfers of control of reverse auction applicants, during the incentive auction provided that the assignment or transfer application: (1) has been accepted for filing with the Commission as of the deadline for submitting reverse auction applications; and (2) includes the express representation that the party will hold the license(s) upon consummation agrees to be bound by the original applicant's actions in the auction with respect to the license(s). *Prohibited Communications PN* at 9–10, paras. 23–24.

⁹⁹ See 47 C.F.R. § 1.2204(d)(3).

¹⁰⁰ An applicant's FCC Form 177 and associated attachments will remain pending until the release of the *Channel Reassignment PN*.

applicant must furnish additional or corrected information to the Commission within five days after a significant occurrence,¹⁰¹ or amend its FCC Form 177 no more than five days after the applicant becomes aware of the need for the amendment.¹⁰² An applicant's obligation to make modifications to a pending application in order to provide additional or corrected information continues in accordance with the Commission's rules.¹⁰³ An applicant is obligated to amend its pending application even if a reported change is considered to be a major modification that may result in the dismissal of the application.

c. Submitting Modifications to FCC Form 177

51. If an applicant needs to make permissible minor changes to its FCC Form 177, or must make changes in order to maintain the accuracy and completeness of its application pursuant to sections 1.65 and 1.2204(d)(5), during a time when the system is available to the applicant for purposes of making the type of change(s) required, such changes should be made electronically to its FCC Form 177 using the Auction System. For the change to be submitted and considered by the Commission, an applicant must click on the SUBMIT button. After the revised application has been submitted, a confirmation page will be displayed stating the submission time, submission date, and a unique file number.¹⁰⁴

52. An applicant cannot use the Auction System outside of the initial and resubmission filing windows to make changes to its FCC Form 177 for other than administrative changes (e.g., changing responsible party or contact person name and related information, adding or deleting an authorized bidder). If other permissible minor changes need to be made, or if changes are required pursuant to sections 1.65 and 1.2204(d)(5), outside of these windows, the applicant must submit a letter briefly summarizing the changes to its FCC Form 177 by e-mail to auction1001@fcc.gov. The e-mail summarizing the changes must include a subject or caption referring to Auction 1001 and the name of the applicant, for example, "Re: Changes to Auction 1001 Auction Application of XYZ Corp." Any attachments to e-mail must be formatted as Adobe® Acrobat® (PDF) or Microsoft® Word documents. Questions about FCC Form 177 amendments should be directed to the Auctions and Spectrum Access Division at (202) 418-0660. An applicant that submits its changes in this manner must subsequently update its FCC Form 177 in the Auction System once it is open and available to applicants. Moreover, after the initial filing window has closed, the Auction System will not permit an applicant to make certain permissible changes itself (e.g., correcting a misstatement of the applicant's legal classification).¹⁰⁵ If an applicant needs to make a permissible minor change that cannot be made using the Auction System, it must submit a written request by e-mail to auction1001@fcc.gov requesting that the Commission manually make the change on the applicant's behalf. The applicant must then recertify its application by clicking on the SUBMIT button to confirm the change.

53. As with the FCC Form 177, any application amendment and related statements of fact must be certified by an authorized representative of the applicant with authority to bind the applicant. Applicants should note that submission of any such amendment or related statement of fact constitutes a representation by the person certifying that he or she is an authorized representative with such authority, and that the contents of the amendment or statement of fact are true and correct.

¹⁰¹ We remind each applicant of its duty to continuously maintain the accuracy of information submitted in its auction application. *See, e.g., Vermont Telephone Company*, Notice of Apparent Liability for Forfeiture, 26 FCC Red 14130 (2011).

¹⁰² *See* 47 C.F.R. §§ 1.65, 1.2204(d)(5).

¹⁰³ *See id.* §§ 1.65, 1.2204(d)(5).

¹⁰⁴ The Bureau advises applicants to retain a copy of this confirmation page.

¹⁰⁵ This is the case because certain fields on the FCC Form 177 will no longer be available to/changeable by the applicant after the initial application filing window closes.

54. Applicants must not submit application-specific material through the Commission's Electronic Comment Filing System. Further, as discussed in the *Prohibited Communications PN*, parties submitting information related to their applications should use caution to ensure that their submissions do not contain confidential information or communicate information that would violate section 1.2205.¹⁰⁶ A party seeking to submit, outside of the Auction System, information that might reflect non-public information, such as a party's decision to submit an application, any applicant's name, or any other information identifying a reverse auction applicant, should consider submitting any such information along with a request that the filing or portions of the filing be withheld from public inspection until the end of the prohibition of certain communications pursuant to section 1.2205.

D. Auction 1001 Process

1. Online Auction Tutorials and Training

55. Prior to the deadline to apply to participate in the reverse auction, the Commission will provide, in various formats, detailed educational information to would-be participants and channel sharers. Among other things, the Commission will hold workshops/webinars addressing the reverse auction application and bidding processes. In addition, Commission staff will provide two auction tutorials for prospective bidders to walk through the auction process and the application and bidding screens. The first auction tutorial will focus on the application process and the second tutorial will focus on the bidding process. These online tutorials will provide information about pre-auction procedures, completing reverse auction applications, auction conduct, the auction bidding system, and auction rules. The application tutorial will be available on the Auction 1001 web page no later than November 17, 2015, and the bidding process tutorial will be available no later than February 29, 2016.

56. Based on our experience with past auctions, parties interested in participating in this auction will find the interactive, online tutorials an efficient and effective way to further their understanding of the auction process. The tutorials will allow viewers to navigate the presentation outline, review written notes, listen to audio recordings of the notes, and search for topics using a text search function. Additional features of this web-based tool include links to auction-specific Commission releases, e-mail links for contacting Commission licensing and auctions staff, and screen shots of the online application and bidding system. The tutorials will be accessible through a web browser with Adobe Flash Player.¹⁰⁷

57. The auction tutorials will be accessible from the Commission's Auction 1001 web page at <http://www.fcc.gov/auctions/1001> through an "Auction Tutorial" link under the "Education" tab. Once posted, these tutorials will remain available and accessible anytime for reference in connection with the procedures outlined in this Public Notice.

2. FCC Form 177– Due Prior to 6:00 p.m. ET on December 18, 2015

58. As the first step to qualify to bid in the clock rounds of the reverse auction, an applicant must follow the procedures provided in the forthcoming FCC Form 177 Instructions to submit an application to participate in the reverse auction (FCC Form 177) electronically via the Auction System.

59. An applicant may file its application to participate in Auction 1001 during the filing window that will open at noon ET on December 1, 2015, and close at 6:00 p.m. ET on December 18, 2015. The application must be submitted **prior to** the closing of the filing window. **Late applications**

¹⁰⁶ See *Prohibited Communications PN* at 16, para. 46 n.76.

¹⁰⁷ Most users will already have the Flash Player browser plug-in, which can be downloaded from <http://get.adobe.com/flashplayer/>.

will not be accepted. No application fee is required.¹⁰⁸ We strongly encourage applicants to file early. Potential applicants are responsible for allowing adequate time for filing their applications. There are no limits or restrictions on the number of times an application can be updated or amended until the filing deadline on December 18, 2015.

60. An applicant must always click on the SUBMIT button on the “Certify & Submit” screen to successfully submit its FCC Form 177 and any modifications; otherwise the application or changes to the application will not be received or reviewed by Commission staff. Additional information about accessing, completing, and viewing the FCC Form 177 will be included in the FCC Form 177 Instructions. FCC Auctions Technical Support is available at (877) 480-3201, option nine; (202) 414-1250; or (202) 414-1255 (text telephone (TTY)); hours of service are Monday through Friday, from 8:00 a.m. to 6:00 p.m. ET. In order to provide better service to the public, all calls to Technical Support are recorded.

3. Application Processing

61. After the deadline for filing reverse auction applications to participate, Commission staff will process all timely submitted applications to determine whether the application is complete as to each station the applicant identified to relinquish spectrum usage rights. Subsequently, the Bureau will send confidential letters to the contact person listed on the applicant’s FCC Form 177 identifying as to each station whether the application (1) is complete, (2) has been rejected, or (3) is incomplete or deficient because of minor defects that may be corrected. The letter will include the deadline for resubmitting corrected applications¹⁰⁹ and will inform the applicant of any potential FCC liabilities with respect to a particular station that cannot be resolved before the reverse auction.¹¹⁰ Applicants that fail to correct defects in their applications to participate by the deadline will have their applications dismissed with no opportunity for resubmission.¹¹¹

62. Applicants will be provided a limited opportunity to cure specified defects and to resubmit a corrected application. We caution, however, that any application to participate that does not contain all of the certifications required pursuant to the Commission’s rules cannot be corrected subsequent to the initial application filing deadline, and will be dismissed.¹¹² During the resubmission period for curing defects, an auction application may be amended or modified to cure identified defects or to make minor amendments or modifications.

63. After the resubmission filing deadline, Commission staff will determine whether an applicant’s resubmitted application is complete *as to each station the applicant included in the application*. The staff will send a confidential letter to the contact person listed in the FCC Form 177 notifying him or her of the final status of its application to participate in the reverse auction with respect to each station in the application. If the application is complete for one or more stations, the letter will contain information about how to submit an initial commitment for those complete stations, which as discussed below, is the second step in qualifying to bid in the clock rounds of the reverse auction.¹¹³

¹⁰⁸ As discussed below, in addition to submitting an auction application, a reverse auction applicant must make an initial commitment by March 29, 2016, in order to qualify to bid in the clock rounds of the reverse auction. *See* § II.D.4 (Initial Commitment).

¹⁰⁹ *See* 47 C.F.R. § 1.2204(d)(4); *see also* § II.C.7 (Modifications to FCC Form 177) (discussing minor changes to applications).

¹¹⁰ *See* § II.C.6 (Provisions Regarding Pending Proceedings).

¹¹¹ 47 C.F.R. § 1.2204(d)(4).

¹¹² *Id.* § 1.2204(d)(2).

¹¹³ If the application is deemed not complete as to any particular station the applicant will not be able to make an initial commitment for that station.

64. Commission staff will communicate only with an applicant's contact person or certifying official, as designated on the auction application, unless the applicant's certifying official or contact person notifies the Commission in writing that the applicant's counsel or other representative is authorized to speak on its behalf.¹¹⁴ Authorizations may be sent by e-mail to auction1001@fcc.gov.

4. Initial Commitment

65. As the second step to qualify to bid in the clock rounds of the reverse auction, an applicant that has submitted a timely and complete application¹¹⁵ must commit, at the opening price, to a preferred relinquishment option for each station that it intends to bid for in the reverse auction prior to 6:00 p.m. ET on March 29, 2016. For each station deemed complete, an applicant may only commit to a relinquishment option(s) that it identified for that station when initially submitting its auction application.¹¹⁶ An applicant will receive instructions on how to submit an initial commitment for such stations in the confidential letter that informs the applicant whether the station has been deemed complete.

66. An applicant's initial commitment to a relinquishment option constitutes an initial bid, and as such, is an irrevocable offer by the applicant to relinquish the relevant spectrum usage rights in exchange for the opening price offer for that bid option if that station is selected to be a winning station.¹¹⁷ An applicant that fails to commit to an initial relinquishment option for a given station by the deadline will not be qualified to bid in the clock rounds of the auction for that station. Applicants should carefully review the *Auction 1000 Bidding Procedures PN* for further details concerning how the selection of a preferred option and a fallback option may affect its bidding options in the clock rounds.¹¹⁸

67. Based on the initial commitments, the Auction System will determine an initial clearing target for the incentive auction. Once the initial clearing target has been determined, the Bureau will send a confidential letter to each reverse auction applicant to inform it of its status with respect to the clock rounds of the reverse auction. The letters will notify the applicant at the contact address provided in the Form 177, for each station included in the application, either that (1) the station is qualified to participate

¹¹⁴ In no event, however, will the FCC send auction registration materials to anyone other than the contact person listed on the Form 177 or respond to a request for replacement registration materials from anyone other than the authorized bidder, contact person, or certifying official listed on the applicant's FCC Form 177. See § II.D.5 (Qualified Bidder Registration Materials).

¹¹⁵ See § II.D.3 (Application Processing) (discussing the application review process and how an applicant will know whether its application is complete as to any particular station).

¹¹⁶ For instance, an applicant with a station located in UHF will be given three options for that station on its auction application (go off-air, move to Low-VHF, and move to High-VHF). If the applicant only identifies move to Low-VHF and move to High-VHF on its application, that applicant will only be able to commit to move to Low-VHF or to High-VHF. Going off-air will not be available because the applicant did not identify that option on its auction application. The addition of an option will not be allowed after the initial filing deadline and will be considered a major modification. See § II.C.7 (Modifications to FCC Form 177) (discussing major and minor modifications to the auction application).

¹¹⁷ As described in the *Auction 1000 Bidding Procedures PN*, in the first clock round of the reverse auction, most bidders will be offered a lower price to relinquish those spectrum usage rights. Each time a bidder accepts a lower price it is committing to relinquish the relevant spectrum usage rights at the price offered. See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9034–42, paras. 110–31.

¹¹⁸ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9020–22, paras. 70–72. Due to the limited availability of VHF channels and the technical constraints on repacking, the auction system may not be able to accommodate every station that commits to move to the Low- or High-VHF band. In order to increase the likelihood any station will be able to participate in the auction, an applicant that commits to move to VHF as its preferred option may also commit to a fallback option(s) if it so chooses. A commitment to a fallback relinquishment option is treated as a binding commitment in the alternative to the preferred option.

in the clock rounds of the reverse auction; (2) the station is not qualified because no initial commitment was made, and therefore, that station will be designated to be repacked in its pre-auction band; (3) the commitment(s) made by the applicant for the station could not be accommodated, and therefore, that station is not qualified and will be designated to be repacked in its pre-auction band; or (4) the Auction System determined that the station is not needed to meet the initial or any subsequent clearing target, and therefore, the station is not qualified and will be designated to be repacked in its pre-auction band.¹¹⁹

5. Qualified Bidder Registration Materials

68. All qualified bidders in the reverse auction are automatically registered for the auction. The materials needed to participate in the clock rounds of the reverse auction will be distributed by overnight mail. The mailing will be sent to the contact person at the contact address listed in the FCC Form 177 and will include the SecurID® tokens that each authorized bidder will need to place bids, the auction system bidder's guide, and the Auction Bidder Line phone number.

69. Bidders qualified to bid in the reverse auction clock rounds that do not receive this registration mailing will not be able to submit bids. Therefore, if this mailing is not received by noon on five days prior to the mock auction, call the Auctions Hotline at (717) 338-2868. Receipt of this registration mailing is critical to participating in the auction, and each applicant is responsible for ensuring it has received all of the registration materials.

70. In the event that SecurID® tokens are lost or damaged, only a person who has been designated as an authorized bidder, the contact person, or the certifying official on the applicant's application to participate in the reverse auction may request replacements. To request replacement of these items, call Technical Support at (877) 480-3201, option nine; (202) 414-1250; or (202) 414-1255 (TTY).

6. Remote Electronic Bidding

71. The Commission will conduct this auction over the Internet, and telephonic bidding will be available as well. All telephone calls are recorded. Only qualified bidders are permitted to bid. Each applicant should indicate its bidding preference—electronic or telephonic—on its FCC Form 177 application. In either case, each authorized bidder must have its own designated SecurID® token, which the Commission will provide at no charge. Each authorized bidder will be issued a unique SecurID® token. **For security purposes, the SecurID® tokens, the telephonic bidding telephone number, and the "Reverse Auction System Bidder's Guide" are only mailed to the contact person at the contact address listed on the FCC Form 177.** Each SecurID® token is tailored to a specific auction and designated authorized bidder. SecurID® tokens issued for other auctions or obtained from a source other than the Commission will not work for Auction 1001.

72. Please note that the SecurID® tokens can be recycled, and the Bureau encourages bidders to return the tokens to the FCC. Pre-addressed envelopes will be provided to return the tokens once bidding has closed.

7. Mock Auction

73. All bidders qualified to bid in the clock rounds will be able to participate in a mock reverse auction prior to the start of the bidding, which will enable bidders to obtain hands-on experience with the Auction System. The mock auction will enable bidders to become familiar with the Auction

¹¹⁹ As part of the process of determining the initial clearing target, the Auction System may determine that certain stations will always have a feasible assignment in their pre-auction band at the initial and all subsequent clearing targets. Such stations' spectrum usage rights will never need to be purchased to meet the clearing target and their participation in the reverse auction is not needed. See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9022, para. 73 n.271.

System prior to the auction. The Bureau strongly recommends that all bidders participate in the mock auction.

74. We anticipate that we will need to conduct at least two mock auctions to accommodate the large number of broadcasters that we expect will qualify to bid in the reverse auction. In the final confidential status letter, each qualified bidder will be notified of the date of the mock auction to which it has been assigned.

III. APPLYING TO PARTICIPATE IN THE FORWARD AUCTION

75. Auction 1002 will offer new, flexible-use licenses suitable for providing mobile broadband services, which will be licensed on a geographic area basis according to Partial Economic Areas (“PEAs”).¹²⁰ As more fully explained in the *Auction 1000 Bidding Procedures PN*, Auction 1002 will consist of two phases—an ascending clock phase and an assignment phase.

A. Applicable Rules and Disclaimers

1. Relevant Authority

76. As more fully explained in the *Auction 1000 Bidding Procedures PN*, the Commission will conduct Auction 1002 pursuant to Title VI of the Spectrum Act.¹²¹ Prospective applicants for Auction 1002 must familiarize themselves thoroughly with the specific rules and policies adopted by the Commission to provide the necessary framework for the forward auction,¹²² including service rules relating to the 600 MHz Band,¹²³ potential impairments and transition periods affecting the licenses offered in the auction, and rules relating to applications, environmental review requirements, practice and procedure.¹²⁴ Prospective applicants must also familiarize themselves with the Spectrum Act, as well as the Commission’s general competitive bidding rules in Part 1, Subpart Q of the Code of Federal Regulations,¹²⁵ Commission decisions in proceedings regarding competitive bidding procedures and obligations of Commission licensees¹²⁶—particularly the Commission’s recent *Part 1 R&O*¹²⁷—and with the procedures, terms, and conditions contained in this Public Notice, the *Auction 1000 Bidding Procedures PN*,¹²⁸ the *Prohibited Communications PN*,¹²⁹ and any other public notices related to Auction 1000, including Auction 1002.¹³⁰

77. The terms contained in the Commission’s rules, relevant orders, and public notices are not negotiable. The Commission may amend or supplement the information contained in its public

¹²⁰ See *Incentive Auction R&O*, 29 FCC Rcd 6569, 6569, para. 1, 6572–73, paras. 9–10, 6580, para. 32; see also 47 C.F.R. §§ 27.5, 27.6; *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9047-9054, paras. 143-153.

¹²¹ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8980, para. 4.

¹²² See generally *Incentive Auction R&O*, 29 FCC Rcd 6569; *Channel Sharing Report and Order*, 27 FCC Rcd 4616; *Mobile Spectrum Holdings R&O*, 29 FCC Rcd 6133; *ISIX Order and Further Notice*, 29 FCC Rcd 13071; *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd 8975; see also *Part 1 R&O*, 30 FCC Rcd 7493.

¹²³ See 47 C.F.R. Part 27.

¹²⁴ See, e.g., 47 C.F.R. Part 1, Subpart I and Q.

¹²⁵ See 47 C.F.R. Part 1, Subpart Q.

¹²⁶ See, e.g., *Part 1 Fifth Report and Order*, 15 FCC Rcd 15293; *Part 1 Seventh R&O*, 16 FCC Rcd 17546; *Part 1 Eighth R&O*, 17 FCC Rcd 2962; *Part 1 Third R&O Second Recon/Part 1 Fifth R&O Recon*, 18 FCC Rcd 10180; *Part 1 Fifth R&O Second Recon*, 20 FCC Rcd 1942.

¹²⁷ See *Part 1 R&O*, 30 FCC Rcd 7493.

¹²⁸ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8975.

¹²⁹ *Prohibited Communications PN*, DA 15-1129.

¹³⁰ See 47 C.F.R. §§ 1.2101–1.2114 and 1.2200–1.2209.

notices at any time, and will issue public notices to convey any new or supplemental information to applicants. It is the responsibility of all applicants to remain current with all Commission rules and with all public notices pertaining to this auction. Copies of most auction-related Commission documents, including public notices, can be retrieved from the FCC Auctions website at <http://wireless.fcc.gov/auctions>. Additionally, documents are available for public inspection and copying at the FCC's headquarters located at 445 12th Street, SW, Washington, DC 20554 during normal business hours.

2. International Coordination

78. Potential bidders seeking licenses for geographic areas adjacent to the Canadian and Mexican borders should be aware that the use of some or all of the 600 MHz Band frequencies they acquire in the forward auction are subject to international agreements with Canada and Mexico.¹³¹ Potential bidders should be aware that, until such time as any new agreements between the United States, Mexico, and/or Canada can be made, wireless operations in the 600 MHz Band must not cause harmful interference to, and must accept harmful interference from, television broadcast operations in Mexico and Canada.¹³² As the Commission noted in the *Incentive Auction R&O*, the Commission routinely works with the United States Department of State and Canadian and Mexican government officials to ensure the efficient use of the spectrum as well as interference-free operations in the border areas near Canada and Mexico.¹³³ The Commission has finalized arrangements with Industry Canada (IC) and the Instituto Federal de Telecomunicaciones (IFT) that set forth a framework and common guidelines for repurposing TV spectrum for mobile broadband on both sides of the borders.¹³⁴ These arrangements significantly reduce potential interference to future wireless operations in the border regions and provide assurance that mobile broadband services in the border markets will face less potential interference from Canadian or Mexican television broadcast stations.¹³⁵

3. Quiet Zones

79. Licensees that intend to operate base and fixed stations in the downlink portion of the 600 MHz Band in close proximity to Radio Astronomy Observatories must follow the procedures set forth in the Commission's rules.¹³⁶

4. Due Diligence

80. A Commission spectrum auction represents an opportunity to become a Commission licensee, subject to certain conditions and regulations. A Commission auction does not constitute an

¹³¹ See *Incentive Auction R&O*, 29 FCC Rcd at 6677-78, paras. 246-252, 6680, para. 257; 47 C.F.R. § 27.57(b). See also *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8986, para. 16 n.52.

¹³² 47 C.F.R. § 27.57(b). See also *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8986, para. 16 n.52.

¹³³ See *Incentive Auction R&O*, 29 FCC Rcd at 6677-78, paras. 247-252.

¹³⁴ *Statement of Intent Between the Federal Communications Commission of the United States of America and the Department of Industry Canada Related to the Reconfiguration of Spectrum Use in the UHF Band for Over-the-Air Television Broadcasting and Mobile Broadband Services*, U.S.-Can., Aug. 11, 2015, available at <https://transition.fcc.gov/ib/sand/agree/files/PASIIC.pdf> (*Canadian Coordination*); *Exchange of Coordination Letters with IFT Regarding DTV Transition and Reconfiguration of 600 MHz Band Spectrum*, U.S.-Mex., July 15, 2015, available at <http://wireless.fcc.gov/incentiveauctions/learn-program/resources.html> (*Mexican Coordination*).

¹³⁵ Pursuant to joint planning between the Commission and Industry Canada, see generally *Canadian Coordination*, and in light of Industry Canada's decision to repurpose the 600 MHz Band, see Indus. Can., *Decision on Repurposing the 600 MHz Band*, SLBP-004-15 (2015), available at <https://www.ic.gc.ca/eic/site/smt-gst.nsf/eng/sf11049.html>, the 138 and 144 megahertz clearing targets will not be considered in order to better harmonize the 600 MHz Band Plan between the two countries. See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8986, para. 16 n.52; *Canadian Coordination* at 2 n.4.

¹³⁶ See 47 C.F.R. § 27.19. See also *Incentive Auction R&O*, 29 FCC Rcd at 6694, para. 294; 47 C.F.R. § 1.924.

endorsement by the Commission of any particular service, technology, or product, and the Commission makes no representations or warranties about the use of the spectrum offered in Auction 1002 for particular services. A Commission license does not constitute a guarantee of business success, and each applicant should therefore perform its due diligence research and analysis before proceeding, as it would with any new business venture, to ensure that any licenses won in this auction will be suitable for its business plans and needs.

81. Each potential bidder is solely responsible for investigating and evaluating all legal, technical, and marketplace factors and risks associated with the licenses that it is seeking in Auction 1002, evaluating the degree to which those factors and risks may have a bearing on the value of the licenses and/or affect the bidder's ability to bid on, otherwise acquire, or make use of such licenses, and conducting any technical analyses necessary to assure itself that, if it wins any license(s), it will be able to build and operate facilities in accordance with the Commission's rules. Each potential bidder's due diligence efforts should include, among other things: (1) reviewing all Commission orders and public notices establishing rules and policies for the 600 MHz Band, including but not limited to spectrum use during the Post-Auction Transition Period¹³⁷ and potential impairments affecting certain licenses;¹³⁸ (2) conducting research to determine the existence of any pending administrative or judicial proceedings, including pending allocation rulemaking proceedings, that might affect its decision to participate in the auction;¹³⁹ (3) performing (or refreshing previous) technical analyses; and (4) inspecting any prospective transmitter sites located in, or near, the service area for which it plans to bid and confirming the availability of such sites and their conformance with applicable federal, state, and local land use requirements.¹⁴⁰ Each potential bidder must undertake its own assessment of the relevance and importance of information gathered as part of its due diligence efforts.

¹³⁷ See *Incentive Auction R&O*, 29 FCC Rcd at 6782–847, paras. 525–688 (§ V). See also *Comment Sought on Defining Commencement of Operations in the 600 MHz Band*, GN Docket No. 12-268, Public Notice, FCC 15-38, 30 FCC Rcd 3200 (2015). The Post-Auction Transition Period is the 39-month period for broadcasters that are assigned new channels in the repacking process and winning UHF-to-VHF and high-VHF-to-low-VHF bids to relocate to new channels, and it commences upon the public release of the *Channel Reassignment Public Notice*. *Incentive Auction R&O*, 29 FCC Rcd at 6796, para. 559.

¹³⁸ For the 600 MHz Band technical rules and the flexible-use service rules, which specify the terms under which the FCC issues licenses in the 600 MHz Band, licensees should refer to *Incentive Auction R&O*. *Incentive Auction R&O*, 29 FCC Rcd at 6860–93, paras. 712–806 (§ VI.B); *Id.* at 6895–6946, App. A. (Final Rules). If the license is subject to an impairment—i.e., areas within the license area where a wireless licensee may not be able to provide service because it would interfere with a broadcast licensee's coverage area or conversely, those license areas in which a wireless provider may receive harmful interference from remaining television operations in or near the 600 MHz Band—licensees should refer to the forthcoming *ISIX Third Report and Order and Order on Reconsideration* for rules governing the inter-service interference environment in the 600 MHz Band.

¹³⁹ The Commission's statutory authority under the Communications Act to add, modify and eliminate rules governing spectrum use, as the public interest warrants, applies equally to all licenses, whether acquired through the competitive bidding process or otherwise. See 47 U.S.C. §§ 309(j)(6)(C)-(D); *Celtronix Telemetry, Inc. v. FCC*, 272 F.3d 585 (D.C. Cir. 2001). The Bureau strongly encourages each participant in Auction 1002 to continue such research throughout the auction. Pending and future Commission and judicial proceedings—including applications, applications for modification, rulemaking proceedings, requests for special temporary authority, waiver requests, petitions to deny, petitions for reconsideration, informal objections, and applications for review—may relate to particular applicants or the licenses available in Auction 1002 (or the terms and conditions thereof, including all applicable Commission rules and regulations), and each prospective applicant is responsible for assessing the likelihood of the various possible outcomes and for considering the potential impact on licenses available in this auction.

¹⁴⁰ See, e.g., 47 U.S.C. §§ 332(c)(7); 47 U.S.C. § 1455(a); *Acceleration of Broadband Deployment By Improving Wireless Facilities Siting Policies*, WT Docket No. 13-238, WC Docket No. 11-59, WT Docket No. 13-32, Report and Order, FCC 14-153, 29 FCC Rcd 12865 (2014).

82. Applicants should bear in mind that the due diligence considerations mentioned in this Public Notice do not comprise an exhaustive list of steps that should be undertaken prior to participating in this auction. As always, the burden is on the potential bidder to determine how much research to undertake, depending upon specific facts and circumstances related to its interests.

5. Use of Auction System

83. Bidders will be able to participate in Auction 1002 over the Internet using the Commission's bidding system ("Auction System"). The Commission makes no warranty whatsoever with respect to the Auction System. In no event shall the Commission, or any of its officers, employees, or agents, be liable for any damages whatsoever (including, but not limited to, loss of business profits, business interruption, loss of business information, or any other loss) arising out of or relating to the existence, furnishing, functioning, or use of the Auction System that is accessible to qualified bidders in connection with this auction. Moreover, no obligation or liability will arise out of the Commission's technical, programming, or other advice or service provided in connection with the Auction System.

6. Fraud Alert

84. As is the case with many business investment opportunities, some unscrupulous entrepreneurs may attempt to use Auction 1002 to deceive and defraud unsuspecting investors. Common warning signals of fraud include the following:

- The first contact is a "cold call" from a telemarketer, or is made in response to an inquiry prompted by a radio or television infomercial.
- The offering materials used to invest in the venture appear to be targeted at IRA funds, for example, by including all documents and papers needed for the transfer of funds maintained in IRA accounts.
- The amount of investment is less than \$25,000.
- The sales representative makes verbal representations that (a) the Internal Revenue Service, Federal Trade Commission ("FTC"), Securities and Exchange Commission ("SEC"), FCC, or other government agency has approved the investment; (b) the investment is not subject to state or federal securities laws; or (c) the investment will yield unrealistically high short-term profits. In addition, the offering materials often include copies of actual FCC releases, or quotes from FCC personnel, giving the appearance of FCC knowledge or approval of the solicitation.

85. Information about deceptive telemarketing investment schemes is available from the FCC as well as the FTC and SEC. Additional sources of information for potential bidders and investors may be obtained from the following sources:

- the FCC's Consumer Call Center at (888) 225-5322 or by visiting <http://wireless.fcc.gov/csinfo#fraud>
- the FTC at (877) FTC-HELP ((877) 382-4357) or by visiting <http://ftc.gov/bcp/edu/pubs/consumer/invest/inv03.shtm>
- the SEC at (202) 942-7040 or by visiting <https://www.sec.gov/investor>.

86. Complaints about specific deceptive telemarketing investment schemes should be directed to the FTC, the SEC, or the National Fraud Information Center at (202) 835-0618.

7. Environmental Review Requirements

87. Licensees must comply with the Commission's rules regarding implementation of the National Environmental Policy Act and other federal environmental statutes.¹⁴¹ The construction of a wireless antenna facility is a federal action, and the licensee must comply with the Commission's environmental rules for each such facility.¹⁴² These environmental rules require, among other things, that the licensee consult with expert agencies having environmental responsibilities, including the U.S. Fish and Wildlife Service, the State Historic Preservation Office, the U.S. Army Corps of Engineers, and the Federal Emergency Management Agency (through the local authority with jurisdiction over floodplains). In assessing the effect of facility construction on historic properties, the licensee must follow the provisions of the Commission's Nationwide Programmatic Agreement Regarding the Section 106 National Historic Preservation Act Review Process.¹⁴³ The licensee must prepare an environmental assessment for any facility that may have a significant impact in or on wilderness areas, wildlife preserves, threatened or endangered species, designated critical habitats, historical or archaeological sites, Native American religious sites, floodplains, surface features, or migratory birds. In addition, the licensee must prepare an environmental assessment for any facility that includes high intensity white lights in residential neighborhoods or excessive radio frequency emission.

B. Auction Specifics

1. Auction Title and Start Date

88. The forward portion of the Incentive Auction will be referred to as "Auction 1002 – Broadcast Television Spectrum Incentive Forward Auction." Auction 1002 dates and deadlines are listed below. The clock phase of the initial stage of Auction 1002 will begin on the second business day after the close of bidding in the reverse auction (Auction 1001), but no sooner than 15 business days after the release of a public notice announcing all qualified bidders for the forward auction ("*Auction 1002 Qualified Bidders PN*").¹⁴⁴ Unless otherwise announced, bidding on all generic spectrum blocks in all PEAs will be conducted on each business day until bidding has stopped on all spectrum blocks in all PEAs. Following the conclusion of the clock phase in the final stage, the Auction System will make available more detailed information about the assignment phase to the winning clock phase bidders five business days before starting the assignment phase.¹⁴⁵

2. Auction 1002 Dates and Deadlines

89. The following dates and deadlines apply:

Pre-Auction Process Tutorial Available (via Internet).....January 7, 2016

FCC Form 175 Filing Window Opens.....January 14, 2016; 12:00 noon ET

FCC Form 175 Filing Window Deadline.....January 28, 2016; 6:00 p.m. ET

Bidding and Post-Auction Process Tutorial

Available (via Internet).....February 29, 2016

¹⁴¹ 47 C.F.R. Chapter 1, Part 1, Subpart I.

¹⁴² 47 C.F.R. §§ 1.1301–1.1319.

¹⁴³ 47 C.F.R. Part 1, App. C. *See also* <https://www.fcc.gov/encyclopedia/tower-and-antenna-siting>.

¹⁴⁴ *Auction 1000 Bidding Procedure PN*, 30 FCC Rcd at 9042-43, para. 133.

¹⁴⁵ *See id.* at 9087, para. 240. Winning bidders from the clock phase will be given scheduling information and bidding options for the assignment round in the Auction System.

Practice Auction.....	Spring 2016
Initial Commitment Deadline	March 29, 2016; 6:00 p.m. ET ¹⁴⁶
Initial Clearing Target and Band Plan Announced	Three to four weeks after the initial commitment deadline
Upfront Payments (via wire transfer).....	By the deadline announced in the <i>Upfront Payments PN</i> ; 6:00 p.m. ET
Clock and Assignment Phase Mock Auction.....	To be announced in the <i>Auction 1002 Qualified Bidders PN</i>
Clock-Phase Auction Begins	To be announced in the <i>Auction 1002 Qualified Bidders PN</i>

3. Requirements for Participation

90. Those wishing to participate in Auction 1002 must:
- Submit a forward auction application (FCC Form 175) electronically prior to 6:00 p.m. ET, on January 28, 2016 following the electronic filing instructions that will be provided in a separate public notice to be released in the near future (“FCC Form 175 Instructions”);
 - Submit a sufficient upfront payment by 6:00 p.m. ET, on the deadline to be announced in a separate public notice to be released after the initial clearing target and associated band plan scenario has been determined (“*Upfront Payment PN*”); and
 - Comply with all provisions outlined in the *Auction 1000 Bidding Procedures PN* and this Public Notice, as well as applicable Commission rules and policies.

4. Auction Delay, Suspension, or Cancellation

91. By public notice or by announcement during the forward auction, the auction may be delayed, suspended, or cancelled in the event of natural disaster, technical obstacle, network disruption, evidence of an auction security breach or unlawful bidding activity, administrative or weather necessity, or for any other reason that affects the fair and efficient conduct of the competitive bidding.¹⁴⁷ In such cases, the Bureau, in its sole discretion, may elect to resume the competitive bidding starting from the beginning of the current round or from some previous round or cancel the auction in its entirety. We emphasize that we will exercise this authority solely at our discretion.

C. Forward Auction Application (FCC Form 175)

92. An application to participate in the forward auction (FCC Form 175) is the first part of the Commission’s two-part auction application process for Auction 1002. The FCC Form 175 is a streamlined application filed by parties seeking to participate in an auction that provides information used

¹⁴⁶ This deadline applies only to Auction 1001 applicants and is included in the forward auction portion of this Public Notice for reference purposes.

¹⁴⁷ See generally 47 C.F.R. § 1.2104(i).

by Commission staff to determine whether the applicant is legally, technically, and financially qualified to participate in Commission auctions for licenses or permits.¹⁴⁸ An applicant's eligibility to bid in Auction 1002 is based on the information provided in its FCC Form 175 and required certifications as to the applicant's qualifications, and on the applicant's submission of a sufficient upfront payment.¹⁴⁹ In the second part of the application process for Auction 1002, each winning bidder must file a more comprehensive post-auction application (FCC Form 601) and must have a complete and accurate ownership disclosure information report (FCC Form 602) on file with the Commission.¹⁵⁰

93. Every entity and individual seeking to bid on a license available in Auction 1002 must file an FCC Form 175 electronically via the Auction System prior to 6:00 p.m. ET on January 28, 2016, following the procedures prescribed in the FCC Form 175 Instructions. If an applicant claims eligibility for a bidding credit, the information provided in its FCC Form 175 will be used to determine whether the applicant may request the claimed bidding credit. As more fully explained in the *Prohibited Communications PN*, an applicant that files an FCC Form 175 to participate in Auction 1002 will be subject to the Commission's prohibited communications rules beginning effective as of the application filing deadline.¹⁵¹

94. Applicants bear full responsibility for submitting accurate, complete, and timely auction applications. Each applicant must make a series of certifications under penalty of perjury on its FCC Form 175 related to the information provided in its application and its participation in the auction, and must confirm that it is legally, technically, financially, and otherwise qualified to hold a license.¹⁵² If an Auction 1002 applicant fails to make the required certifications in its FCC Form 175 by the application filing deadline, its application will be unacceptable for filing and cannot be corrected subsequent to the filing deadline.¹⁵³

95. The submission of an FCC Form 175 (and any amendments thereto) constitutes a representation by the person certifying the application that he or she is an authorized representative of the applicant with authority to bind the applicant, that he or she has read the form's instructions and certifications, and that the contents of the application, its certifications, and any attachments are true and correct.¹⁵⁴ Submission of any false certification(s) to the Commission may result in penalties, including monetary forfeitures, license forfeitures, ineligibility to participate in future auctions, and/or criminal prosecution.

96. The Commission's rules prohibit the filing of more than one auction application by the same individual or entity.¹⁵⁵ An individual or entity may therefore not submit more than one application for a single auction. If a party submits multiple applications for any license(s) in a particular auction, only one of its applications can be found to be complete when reviewed for completeness and compliance

¹⁴⁸ See 47 C.F.R. § 1.2105; see also *Competitive Bidding Second Report and Order*, 9 FCC Rcd at 2376, para. 165.

¹⁴⁹ See § III.D.4 (Upfront Payments and Bidding Eligibility). See also *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9025, para. 81, 9026, para. 85.

¹⁵⁰ 47 C.F.R. §§ 1.2107. The Bureau reminds applicants that being deemed qualified to bid in Auction 1002 does not constitute a determination that an entity is qualified to hold a Commission license or is eligible for a designated entity bidding credit.

¹⁵¹ See *Prohibited Communications PN* at 10-11, paras. 25-26, 16, para. 45.

¹⁵² 47 C.F.R. § 1.2105(a)(2).

¹⁵³ See 47 C.F.R. § 1.2105(b)(1).

¹⁵⁴ As more fully explained in § III.C.12 (Modifications to FCC Form 175), applicants are not permitted to make major modifications to their FCC Form 175 applications after the filing deadline. See 47 C.F.R. § 1.2105(b)(2). A change in the official certifying the application is considered a major change and would therefore not be permitted.

¹⁵⁵ See 47 C.F.R. § 1.2105(a)(3); see also *Part 1 R&O*, 30 FCC Rcd at 7579, para. 205.

with the Commission's rules.¹⁵⁶ Similarly, and consistent with the Commission's general prohibition on joint bidding agreements, an entity is generally permitted to participate in a Commission auction only through a single bidding entity.¹⁵⁷ Accordingly, the filing of applications by entities controlled by the same individual or set of individuals will generally not be permitted.¹⁵⁸

97. Below we discuss additional details regarding certain information required to be submitted in the FCC Form 175. However, each applicant should read carefully the Auction 1002 application instructions and consult the Commission's rules to ensure that all of the information required to be submitted in an auction application is included within its application.¹⁵⁹

1. Authorized Bidders

98. An applicant must designate at least one authorized bidder, and no more than three, in its FCC Form 175. The Commission's rules prohibit an individual from serving as an authorized bidder for more than one auction applicant.¹⁶⁰ Accordingly, the same individual may not be listed as an authorized bidder in more than one FCC Form 175.

2. License Area Selection

99. An applicant must select all of the PEA(s) on which it may want to bid from the list of available PEAs on its FCC Form 175.¹⁶¹ The applicant must carefully review and verify its PEA selections before the FCC Form 175 filing deadline because PEA selections cannot be changed after the auction application filing deadline.¹⁶² The Auction System will not accept bids on PEA(s) that were not selected on the applicant's FCC Form 175.

3. Qualification to Bid on Market-Based Spectrum Reserve

100. An entity can qualify to bid on reserved spectrum by either (1) holding an attributable interest in less than 45 megahertz of below-1-GHz spectrum in a given PEA; or (2) being a non-nationwide provider.¹⁶³ The attribution criteria set forth in section 20.22 of the Commission's rules govern qualification to bid on the spectrum reserve under either of the two prongs.¹⁶⁴ To qualify to bid on reserved licenses in a PEA under the first prong, an entity must not have an attributable interest on a population-weighted basis of 45 megahertz or more of below-1-GHz spectrum that is suitable and

¹⁵⁶ See 47 C.F.R. § 1.2105(a)(3); 47 C.F.R. § 1.2105(b)(1)(ii).

¹⁵⁷ See *Part I R&O*, 30 FCC Rcd at 7580-81, paras. 206–208.

¹⁵⁸ See 47 C.F.R. §§ 1.2105(a)(3), (a)(4)(i), (b)(1)(ii); *Part I R&O*, 30 FCC Rcd at 7580-81, paras. 206-208. This restriction applies across all applications in a particular auction, without regard to the licenses or geographic areas selected. See *Part I R&O*, 30 FCC Rcd at 7580, para. 206. The Commission adopted a limited exception to the general prohibition on the filing of multiple applications by commonly-controlled entities for qualified rural wireless partnerships and individual members of such partnerships. See 47 C.F.R. § 1.2105(a)(3). Under this limited exception, each qualifying rural wireless partnership and its individual members will be permitted to participate separately in an auction. See 47 C.F.R. § 1.2105(a)(3); see also *Part I R&O*, 30 FCC Rcd at 7582, para. 210.

¹⁵⁹ As noted above, the FCC Form 175 electronic filing procedures will be provided in FCC Form 175 Instructions.

¹⁶⁰ See 47 C.F.R. § 1.2105(a)(2)(iii); see also *Part I R&O*, 30 FCC Rcd at 7577, para. 200.

¹⁶¹ The application will not ask an applicant to select a number of generic blocks on which it may wish to bid since the number of blocks available in each PEA will not be known at the time applications are due. The number of available blocks will be known prior to the upfront payment deadline, however. See also §III.D.4 (Upfront Payments and Bidding Eligibility).

¹⁶² 47 C.F.R. § 1.2105(b)(2).

¹⁶³ *Mobile Spectrum Holdings R&O*, 29 FCC Rcd at 6207, para. 181. See also *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9063, para. 172.

¹⁶⁴ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9063, para. 173; 47 C.F.R. § 20.22.

available for the provision of mobile telephony/mobile broadband services in that PEA, at the deadline for filing an FCC Form 175 to participate in Auction 1002.¹⁶⁵

101. In this section, the Bureau addresses additional implementation issues related to qualification to bid on the spectrum reserve: (1) an element of the methodology for calculating below-1-GHz spectrum holdings in a PEA, related to cellular license areas; (2) guidance regarding how certain types of rural partnerships, or members thereof, can request status as non-nationwide providers; and (3) logistical details regarding the required certification by applicants of their reserve-eligible qualification in particular PEAs. In addition, Attachment 3 to this Public Notice contains a list, for each PEA, of the nationwide providers that are reserve-eligible in that PEA based on application to our current records of the methodology for calculating below-1-GHz spectrum holdings.

a. Accounting for Cellular License Areas in Calculating Below-1-GHz Spectrum Holdings in a PEA

102. As set forth in the *Mobile Spectrum Holdings R&O*, for purposes of determining reserve-eligibility, the Bureau will calculate an entity's below-1-GHz spectrum holdings in a PEA by summing the product of county spectrum holdings and county population within the PEA (using U.S. Census 2010 population data), and then dividing that sum by the total population of the PEA.¹⁶⁶ We note that 800 MHz cellular service license areas (Cellular Geographic Service Areas or "CGSAs"), which are relevant to determining an entity's below-1-GHz holdings, do not generally follow county lines.¹⁶⁷ As a result, the Bureau will take additional steps to calculate an entity's cellular holdings at the PEA level. Specifically, it will first overlay map files of each service provider's CGSAs as of May 2015 onto map files of census blocks.¹⁶⁸ Next, it will attribute cellular spectrum in each census block to each entity whose CGSA boundary overlaps the geometric center of the block, referred to as the centroid.¹⁶⁹ The Commission has

¹⁶⁵ *Mobile Spectrum Holdings R&O*, 29 FCC Rcd at 6204-6205, para. 175. A total of 134 megahertz of below-1-GHz spectrum is currently considered to be "suitable" and "available," as follows: 50 megahertz of 800 MHz cellular spectrum, 70 megahertz of 700 MHz spectrum, and 14 megahertz of SMR spectrum. See *Mobile Spectrum Holdings R&O*, 29 FCC Rcd at 6169-6190, Section IV.

¹⁶⁶ As described in the *Mobile Spectrum Holdings R&O*, in those PEAs where there are existing long-term commercial leases, as we attribute the leased spectrum to both the lessee and lessor, we increase the total below-1-GHz spectrum amount included by the population-weighted amount of the lease – and accordingly increase the threshold for reserve-eligibility in those markets to approximately one-third of the total – so that service providers' holdings are not overstated in those markets. *Mobile Spectrum Holdings R&O*, FCC Rcd at 6205, n. 496.

¹⁶⁷ For a description of the cellular licensing framework, see Amendment of Parts 1 and 22 of the Commission's Rules with Regard to the Cellular Service, Including Changes in Licensing of Unserved Area; Amendment of the Commission's Rules with Regard to Relocation of Part 24 to Part 27; Interim Restrictions and Procedures for Cellular Service Applications; Amendment of Parts 0, 1, and 22 of the Commission's Rules with Regard to Frequency Coordination for the Cellular Service; Amendment of the Commission's Rules Governing Radiated Power Limits for the Cellular Service, *Report and Order and Further Notice of Proposed Rulemaking*, 29 FCC Rcd 14100, 14103-04, (2014). Service providers initially were given the exclusive right to build out cellular networks within a Cellular Market Area ("CMA") for a five-year time period, but retained as their license only what they had actually built out at the deadline, which became the licensee's Cellular Geographic Service Area ("CGSA"). In 2014, the Commission defined geographically licensed areas based on CGSA boundaries. *Id.* at 14103, para. 5.

¹⁶⁸ The CGSA map files are available at: <https://www.fcc.gov/encyclopedia/cgsa>. Census block map files are available at: <https://www.census.gov/cgi-bin/geo/shapefiles2010/main>.

¹⁶⁹ The "centroid" refers to the internal point latitude/longitude of a census block polygon. See, e.g., Connect America Fund; A National Broadband Plan for Our Future; Establishing Just and Reasonable Rates for Local Exchange Carriers; High-Cost Universal Service Support; Developing an Unified Intercarrier Compensation Regime; Federal-State Joint Board on Universal Service; Lifeline and Link-Up; Universal Service Reform – Mobility Fund, *Report and Order and Further Notice of Proposed Rulemaking*, 26 FCC Rcd 17663, 17786, n. 576 (2011) (*USF/ICC Transformation Order*). The latitude and longitude of the centroid of each block are available in the census block map files at: <https://www.census.gov/cgi-bin/geo/shapefiles2010/main>.

used this methodology, which relies on publicly available information and is an administratively simple and efficient approach to apply, for determining in other contexts how to categorize individual census blocks.¹⁷⁰ Once the Bureau calculates an entity's holdings in each census block within the PEA, the standard population-weighted methodology is used to aggregate spectrum holdings to the PEA level.¹⁷¹

103. In order to provide an opportunity for potential applicants in Auction 1002 to review the Bureau's current assessment of which of the nationwide providers would qualify to bid on reserve spectrum in each PEA, and to inform applicants of how to determine where they may certify eligibility for bidding on such spectrum, Attachment 3 to this Public Notice includes a list of qualified nationwide providers for each PEA, based on the methodology described above and in the *Mobile Spectrum Holdings R&O*.¹⁷² If an interested party would like to raise potential corrections to this list, it may do so by making a filing in AU Docket No. 14-252, GN Docket No. 12-268, and WT Docket No. 12-269, and sending the filing by electronic mail to catherine.matraves@fcc.gov and karen.sprung@fcc.gov by November 16, 2015. An updated list of all nationwide applicants qualified to bid on reserved spectrum in each PEA will be issued prior to the FCC Form 175 filing deadline. We note that spectrum holdings that are the subject of an application for assignment or transfer of control that has been approved as of the date of this Public Notice will be attributed to the assignee or transferee for purposes of the determinations in Attachment 3 to this Public Notice. The updated list that will be released prior to the FCC Form 175 filing deadline similarly will reflect such attributions as of the date of that updated list.

b. Required Certification of Eligibility for Reserved Spectrum

104. In the *Auction 1000 Comment PN*, the Commission proposed to require an applicant seeking to participate in the forward auction as a reserve-eligible entity to certify in its application that it is a reserve-eligible entity with respect to each PEA in which it wishes to be able to bid for reserved blocks.¹⁷³ The Commission further proposed that an applicant must make this certification in its application and that it shall not be able to revise its certification thereafter.¹⁷⁴ The Commission stated that this approach will enable potentially reserve-eligible applicants to forego reserve-eligible status on a PEA-by-PEA basis, and that requiring applicants intending to bid for reserved spectrum blocks to affirmatively declare their eligibility to do so will avoid any subsequent ambiguity or uncertainty by each applicant regarding its reserve-eligible status.¹⁷⁵ The Commission received no comment on these proposals, and the Bureau therefore adopts a spectrum reserve eligibility certification for Auction 1002.¹⁷⁶

105. Under this certification requirement, an applicant that is eligible to bid on reserved spectrum blocks in a given PEA, and that included the PEA in its license area selection(s), must certify its

¹⁷⁰ See, e.g., *USF/ICC Transformation Order* at 17786-87, paras. 343-44; *Seventeenth Competition Report*, 29 FCC Rcd at 15332-15333, para. 45.

¹⁷¹ Census block cellular spectrum holdings are multiplied by the population of the census block for all census blocks in the PEA. The sum is then divided by the population of the PEA to yield the population-weighted-megahertz cellular spectrum holdings at the PEA level. We note that this methodology produces the same results, and is administratively easier, than a methodology that first aggregates census blocks up to the county level and then aggregates counties up to the PEA level. See *Mobile Spectrum Holdings R&O*, FCC Rcd at 6204-6205, para. 175.

¹⁷² We note that non-nationwide providers can qualify to bid on reserve spectrum irrespective of their below-1-GHz spectrum holdings for the reasons set out in the *Mobile Spectrum Holdings R&O*, and the *Procedures PN*.

¹⁷³ See *Auction 1000 Comment PN*, 29 FCC Rcd at 15804, para. 168. See also *Mobile Spectrum Holdings R&O*, 29 FCC Rcd at 6207, para. 181; *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9055, para. 157, n.484 (The Commission noted that it would revise the FCC Form 175 to provide for a certification by an applicant intending to bid on reserved spectrum that it meets the qualification criteria).

¹⁷⁴ See *Auction 1000 Comment PN*, 29 FCC Rcd at 15804, para. 168.

¹⁷⁵ See *id.*

¹⁷⁶ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8979-80, para. 3.

eligibility to bid for reserved blocks in the PEA. An applicant is not required to bid on, or certify its eligibility for, reserved spectrum blocks in any or all areas in which it is eligible. However, an applicant that does not certify its eligibility with respect to a particular license area because it is not eligible or it declines to do so will not be able to bid for reserved spectrum blocks in that PEA during the auction. Accordingly, any demand by that applicant in that license area will not be counted as demand for reserved spectrum blocks when determining the actual number of blocks that will be reserved in a PEA.

c. Effect of Relationships between a Non-Nationwide Provider and a Nationwide Provider

106. In the *Auction 1000 Bidding Procedures PN*, the Commission recognized a concern that it would be inconsistent with the intent of the reserve, in certain unique circumstances involving limited equity interests by nationwide providers in long-standing rural partnerships, to apply the attribution rule in section 20.22 so as to prevent non-nationwide providers from bidding for reserved spectrum.¹⁷⁷ In particular, the Commission identified specific circumstances in which certain rural partnerships can secure status as non-nationwide providers for purposes of qualifying to bid on the spectrum reserve.¹⁷⁸

107. If a member of a long-standing rural partnership applying to participate in Auction 1002 wishes to assert qualification to bid on reserved spectrum in a PEA on the basis of status as a non-nationwide provider, notwithstanding attributable relationships with AT&T, Verizon, Sprint, or T-Mobile, it should submit an attachment to its FCC Form 175 certifying and detailing how it meets the circumstances specified by the Commission to secure status as a non-nationwide provider for purposes of qualifying to bid on the spectrum reserve.¹⁷⁹

4. Disclosure of Agreements Related to Licenses Being Auctioned

108. An applicant must provide in its FCC Form 175 a brief description of, and identify each party to, any partnerships, joint ventures, consortia, or agreements, arrangements, or understandings of any kind relating to the licenses being auctioned, including any agreements that address or communicate directly or indirectly bids (including specific prices), bidding strategies (including the specific licenses on which to bid or not to bid), or the post-auction market structure, to which the applicant, or any party that controls or is controlled by the applicant, is a party.¹⁸⁰ In connection with the agreement disclosure requirement, the applicant must certify under penalty of perjury in its FCC Form 175 that it has described, and identified each party to, any such agreements, arrangements, or understanding into which it has entered.¹⁸¹ An applicant may continue negotiating, discussing, or communicating with respect to a new

¹⁷⁷ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9064, para. 175. The Commission noted that non-attribution in these types of circumstances may enhance competitive choices for consumers by giving the partnerships an opportunity to gain access to low-band spectrum through the spectrum reserve, without creating an undue risk of anti-competitive behaviors due to the rural partnership's relative lack of resources. *Id.*

¹⁷⁸ These circumstances are where the nationwide provider is not the managing partner of the rural partnership, has not and will not provide funding for the purchase of the licenses in spectrum auctions by the rural partnership, including the incentive auction, the rural partnership is of long standing, the nationwide provider's interest in the rural partnership is non-controlling and is less than 33 percent, and the partnership's retail service is not branded under the name of the nationwide provider. See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9064, para. 175.

¹⁷⁹ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9064, para. 175.

¹⁸⁰ 47 C.F.R. §§ 1.2105(a)(2)(viii), (a)(4). As defined for purposes of this rule, a controlling interest includes all individuals or entities with positive or negative *de jure* or *de facto* control of the licensee. See 47 C.F.R. § 1.2105(a)(4)(i). This definition is modeled on a similar term used in section 1.2110(c) (definitions for designated entities), though it differs in some respects from that rule. Compare 47 C.F.R. § 1.2105(a)(4)(i) with 47 C.F.R. § 1.2110(c).

¹⁸¹ 47 C.F.R. § 1.2105(a)(2)(viii).

agreement after the FCC Form 175 filing deadline, provided that the communications involved do not relate both to the licenses being auctioned and to bids or bidding strategies or post-auction market structure. An Auction 1002 applicant that enters into any agreement relating to the licenses being auctioned during the auction is subject to the same disclosure obligations as it would be for agreements existing at the FCC Form 175 filing deadline and must maintain the accuracy and completeness of the information in its pending auction application.¹⁸²

109. For purposes of making the required agreement disclosures on the FCC Form 175, if parties agree in principle on all material terms prior to the application filing deadline, each party to the agreement that is submitting an auction application must provide a brief description of, and identify the other party or parties to, the agreement on its respective FCC Form 175 pursuant to section 1.2105(a)(2)(viii) and (c)(1), even if the agreement has not been reduced to writing. However, if the parties have not agreed in principle by the FCC Form 175 filing deadline, they should not describe, or include the names of parties to, the discussions on their applications.¹⁸³

110. As recently amended, the Commission's rules now generally prohibit joint bidding and other arrangements involving auction applicants (including any party that controls or is controlled by, such applicants).¹⁸⁴ This prohibition applies to joint bidding arrangements involving two or more nationwide providers, as well as joint bidding arrangements involving a nationwide and one or more non-nationwide providers, where any party to the arrangement is an applicant for the auction.¹⁸⁵ Non-nationwide providers may enter into agreements to form a consortium or a joint venture (as applicable) that result in a single party applying to participate in an auction.¹⁸⁶ Specifically, a designated entity can participate in only one consortium in an auction,¹⁸⁷ which shall be the exclusive bidding vehicle for its members in that auction, and non-nationwide providers may participate in an auction through only one joint venture, which also shall be the exclusive bidding vehicle for its members in that auction.¹⁸⁸ The

¹⁸² See *Prohibited Communications PN*, DA 15-1129 at para. 34; see also 47 C.F.R. §§ 1.65, 1.2105(b)(4); *Auction of Advanced Wireless Services (AWS-3) Licenses Scheduled for November 13, 2014; Notice and Filing Requirements, Reserve Prices, Minimum Opening Bids, Upfront Payments, and Other Procedures for Auction 97*, AU Docket No. 14-78, Public Notice, DA 14-1018, 29 FCC Rcd 8386, 8418, para. 109 (2014) (discussing applicants' obligation to maintain accuracy and completeness of information in pending auction applications).

¹⁸³ See generally *Wireless Telecommunications Bureau Clarifies Spectrum Auction Anti-Collusion Rules*, Public Notice, DA 95-2244, 11 FCC Rcd 9645, 9646 (WTB 1995) (*Anti-Collusion Public Notice*) (standard for determining when a disclosable agreement exists, discussed in connection with an earlier version of section 1.2105 of the Commission's rules).

¹⁸⁴ See 47 C.F.R. § 1.2105(a)(2)(ix); see also *Part 1 R&O*, 30 FCC Rcd at 7569-77, paras. 177-198.

¹⁸⁵ See 47 C.F.R. § 1.2105(a)(2)(ix); see also *Part 1 R&O*, 30 FCC Rcd at 7571, para. 182; 7573, para. 186, 7574; para. 191, 7575, para. 193.

¹⁸⁶ See *Part 1 R&O*, 30 FCC Rcd at 7573, para. 187, 7574, para. 190, 7576, para. 198. While two or more non-nationwide providers may participate in an auction through a joint venture, a nationwide and a non-nationwide provider may not do so. See *id.* at 7575, para. 194.

¹⁸⁷ See *Part 1 R&O*, 30 FCC Rcd at 7576, para. 198. Pursuant to section 1.2105(a)(4)(ii), a consortium is an entity formed to apply as a single applicant to bid at auction pursuant to an agreement by two or more separate and distinct legal entities that individually are eligible to claim the same designated entity benefits under section 1.2110, provided that no member of the consortium may be a nationwide provider. 47 C.F.R. § 1.2105(a)(4)(ii).

¹⁸⁸ See *Part 1 R&O*, 30 FCC Rcd at 7576, para. 198. Under the Commission's newly-adopted rule, a joint venture means a legally cognizable entity formed to apply as a single applicant to bid at auction pursuant to an agreement by two or more separate and distinct legal entities, provided that no member of the joint venture may be a nationwide provider. 47 C.F.R. § 1.2105(a)(4)(iii); see also *Part 1 R&O*, 30 FCC Rcd at 7575, para. 194.

general prohibition on joint bidding arrangements excludes certain agreements, including those that are solely operational in nature,¹⁸⁹ as defined in section 1.2105(a)(2)(ix)(A)-(C) of the Commission's rules.¹⁹⁰

111. For purposes of the prohibition on joint bidding arrangements, "joint bidding arrangements" include arrangements relating to the licenses being auctioned that address or communicate, directly or indirectly, bidding at the auction, bidding strategies, including arrangements regarding price or the specific licenses on which to bid, and any such arrangements relating to the post-auction market structure.¹⁹¹ A "non-nationwide provider" refers to any provider of communications services that is not a "nationwide provider."¹⁹² For Auction 1002, AT&T, Verizon, Sprint, and T-Mobile are considered to be "nationwide providers."¹⁹³

112. In connection with disclosing any agreements related to the licenses being auctioned in Auction 1002, an applicant must certify that neither the applicant, nor any party that controls or is controlled by the applicant, has entered or will enter into any agreements relating to the licenses being auctioned other than those fall within the limited exceptions in section 1.2105(a).¹⁹⁴ Although section 1.2105(c)(1) of the Commission's rules does not prohibit auction applicants from communicating about matters that are within the scope of an agreement described in section 1.2105(a)(2)(ix)(A)-(C) that has been disclosed in an FCC Form 175 pursuant to section 1.2105(a)(2)(viii), the Bureau reminds applicants that certain discussions or exchanges could nonetheless touch upon impermissible subject matters,¹⁹⁵ and that compliance with the Commission's rules will not insulate a party from enforcement of the antitrust laws.¹⁹⁶

¹⁸⁹ See 47 C.F.R. §§ 1.2105(a)(2)(ix)(A) and (a)(4). Under the Commission's rules, agreements that are solely operational in nature are those that address operational aspects of providing a mobile service, such as agreements for roaming, spectrum leasing and other spectrum use arrangements, or device acquisition, as well as agreements for assignment or transfer of licenses, provided that any such agreement does not both relate to the licenses at auction and address or communicate, directly or indirectly, bidding at auction (including specific prices to be bid) or bidding strategies (including the specific licenses on which to bid or not to bid) or post-auction market structure. See 47 C.F.R. § 1.2105(a)(4); see also *Part 1 R&O*, 30 FCC Rcd at 7576, para. 197.

¹⁹⁰ See 47 C.F.R. §§ 1.2105(a)(2)(ix); see also *Part 1 R&O*, 30 FCC Rcd at 7575-76, paras. 195-197.

¹⁹¹ See *Part 1 R&O*, 30 FCC Rcd at 7575, para. 195.

¹⁹² See *id.*; see also *id.* at 7571, n.596 (for purposes of the Commission's competitive bidding rules, entities that qualify as nationwide providers will generally be identified in procedures public notices released before each auction).

¹⁹³ See *Implementation of Section 6002(b) of the Omnibus Budget Reconciliation Act of 1993, Annual Report and Analysis of Competitive Market Conditions With Respect to Mobile Wireless, Including Commercial Mobile Services*, WT Docket No. 13-135, Seventeenth Report, FCC 13-34, 29 FCC Rcd 15311, 15317, para. 12 (2014).

¹⁹⁴ 47 C.F.R. § 1.2105(a)(2)(ix)(A)-(C). In addition, an applicant must certify that it is not, and will not be, privy to, or involved in, in any way the bids or bidding strategy of more than one auction applicant and that, if applicable, it has established procedures to preclude its agents, employees, or related parties, from possessing information about the bids or bidding strategies of more than one applicant or communicating such information regarding another applicant. See 47 C.F.R. §§ 1.2105(a)(x), (c)(2), 1.2112(a)(1)-(6). The Bureau cautions, however, that submission of such a certification by an applicant will not outweigh specific evidence that a communication violating the Commission's rules has occurred, nor will it preclude the initiation of an investigation when warranted. See *Part 1 R&O*, 30 FCC Rcd at 7578, para. 201; see also *Prohibited Communications PN*.

¹⁹⁵ See *Amendment of Part 1 of the Commission's Rules—Competitive Bidding Procedures*, WT Docket No. 97-82, Third Report and Order and Second Further Notice of Proposed Rule Making, FCC 97-413, 13 FCC Rcd 374, 467-68, para. 163 (1997); see generally *Prohibited Communications PN*.

¹⁹⁶ *Id.* 47 C.F.R. §§ 1.2105(a)(2)(ix)(A)-(C), (a)(2)(viii). See also *Part 1 R&O*, 30 FCC Rcd at 7571, para. 181; *Prohibited Communications PN* at 16, para. 43.

113. Applicants should bear in mind that a winning bidder will be required to disclose in its FCC Form 601 post-auction application the specific terms, conditions, and parties involved in any agreement relating to the licenses being auctioned into which it had entered prior to the filing of its FCC Form 175 application.¹⁹⁷ This applies to any bidding consortium, joint venture, partnership, or other agreement, arrangement, or understanding of any kind entered into relating to the competitive bidding process, including any agreements relating to the licenses being auctioned that address or communicate directly or indirectly bids (including specific prices), bidding strategies (including the specific licenses on which to bid or not to bid), or the post-auction market structure, to which the applicant, or any party that controls or is controlled by the applicant, is a party.¹⁹⁸

5. Ownership Disclosure Requirements

114. Each applicant must comply with the uniform Part 1 ownership disclosure requirements and provide information required by sections 1.2105 and 1.2112, and, where applicable, section 1.2110, of the Commission's rules.¹⁹⁹ Specifically, in completing the FCC Form 175, an applicant will be required to fully disclose information on the real party- or parties-in-interest and the ownership structure of the applicant, including both direct and indirect ownership interests of 10 percent or more, as prescribed in sections 1.2105 and 1.2112, and, where applicable, section 1.2110, of the Commission's rules.²⁰⁰

115. In certain circumstances, an applicant's most current ownership information on file with the Commission, if in an electronic format compatible with the FCC Form 175 (such as information submitted in an FCC Form 602 or in an FCC Form 175 filed for a previous auction) will automatically be entered into the applicant's auction application. Each applicant must carefully review any information that has been automatically entered in its FCC Form 175 to confirm that all information supplied on the application is complete and accurate as of the application filing deadline.

6. Foreign Ownership Disclosure Requirements

116. Section 310 of the Communications Act requires the Commission to review foreign investment in radio station licenses and imposes specific restrictions on who may hold certain types of radio licenses.²⁰¹ The provisions of section 310 apply to applications for initial radio licenses, applications for assignments and transfers of control of radio licenses, and spectrum leasing arrangements under the Commission's secondary market rules.²⁰² In completing the FCC Form 175, an applicant will be required to disclose information concerning any foreign ownership of the applicant. If an applicant has a foreign owner(s) with ownership interests in excess of the applicable limit or benchmark set for in section 310, it may seek to participate in Auction 1002 as long as it has filed a petition for declaratory ruling with the Commission prior to the FCC Form 175 filing deadline. An applicant must certify in its FCC Form 175 that, as of the deadline for filing its application to participate in Auction 1002, the applicant either is in compliance with the foreign ownership provisions of section 310 or has filed a

¹⁹⁷ 47 C.F.R. § 1.2107(d). *See also* 47 C.F.R. §§ 1.2105(a)(2)(ix)(A)-(C), (a)(2)(viii).

¹⁹⁸ *Id.*

¹⁹⁹ Section 1.2105 requires the disclosure on the FCC Form 175 of the applicant's ownership information as set forth in sections 1.2105 and 1.2112. *See* 47 C.F.R. § 1.2105. In addition, each applicant should ensure that its disclosures comply with the ownership disclosure requirements in the recently amended Part 1 rules. *See generally Part 1 R&O.*

²⁰⁰ 47 C.F.R. §§ 1.2105, 1.2112.

²⁰¹ *See* 47 U.S.C. §§ 310(a), (b).

²⁰² *See* Review of Foreign Ownership Policies for Common Carrier and Aeronautical Radio Licensees under Section 310(b)(4) of the Communications Act of 1934, as Amended, *Second Report and Order*, FCC 13-50, 28 FCC Rcd 5741, 5747-48, para. 7 (2013) (*Foreign Ownership Second Report and Order*).

petition for declaratory ruling requesting Commission approval to exceed the applicable foreign ownership limit or benchmark in section 310(b) that is pending before, or has been granted by, the Commission.²⁰³

7. National Security Certification

117. The Commission's rules require that any applicant seeking to participate in an auction that is required or authorized to be conducted pursuant to the Spectrum Act must certify in its FCC Form 175, under penalty of perjury, that the applicant and all of the related individuals and entities required to be disclosed on its application are not person(s) who have been, for reasons of national security, barred by any agency of the Federal Government from bidding on a contract, participating in an auction, or receiving a grant, and who are thus statutorily prohibited from participating in such a Commission auction.²⁰⁴ Because the Commission will conduct Auction 1002 under its general competitive bidding rules and Auction 1002 is subject to the national security restriction in section 6004 of the Spectrum Act,²⁰⁵ Auction 1002 applicants must certify as to their compliance with the national security restriction in section 1.2105(a)(xiii).

8. Provisions for Small Businesses and Rural Service Providers

118. The Commission recently revised the designated entity rules that apply to all licenses acquired with bidding credits, including those won in Auction 1002.²⁰⁶ A bidding credit represents an amount by which a bidder's winning bid will be discounted, subject to the caps discussed below.²⁰⁷ As set forth in section 1.2110 of the Commission's rules,²⁰⁸ and as described below, these rule revisions include, but are not limited to: (1) adopting a two-pronged standard for evaluating eligibility for small business benefits and eliminating the attributable material relationship (AMR) rule;²⁰⁹ (2) establishing a new attribution rule for certain disclosable interest holders of applicants claiming designated entity

²⁰³ See 47 C.F.R. § 1.2105(a)(2)(v), (vi). Additional information concerning foreign ownership disclosure requirements will be provided in the forthcoming FCC Form 175 Instructions.

²⁰⁴ See 47 C.F.R. § 1.2105(a)(2)(xiii); see also 47 U.S.C. § 1404. In the *Incentive Auction R&O*, the Commission revised the national security certification to comprehensively include all of the auctions within the scope of section 6004 of the Spectrum Act. See *Incentive Auction R&O*, 29 FCC Rcd at 6773, para. 497. Specifically, the Commission amended the certification to extend its applicability to auctions "in which any spectrum usage rights for which licenses are being assigned were made available under [47 U.S.C. § 309(j)(8)(G)(i)]." See Spectrum Act § 6004(b)(2).

²⁰⁵ The national security restriction in § 6004 of the Spectrum Act applies to the broadcast television spectrum reverse and forward auctions since Title VI requires the Commission to conduct both auctions. See Spectrum Act §§ 6004(b)(1), 6403(a), (c). The forward auction is also subject to the national security restriction because the spectrum usage rights offered in the auction will be made available under 47 U.S.C. § 309(j)(8)(G)(i). See Spectrum Act § 6004(b)(2).

²⁰⁶ The small business size definitions adopted in the *Incentive Auction R&O* have been superseded by the designated entity provisions adopted in the subsequent *Part 1 R&O* for licenses won in Auction 1002. See *Part 1 R&O*, 30 FCC Rcd 7493; *Incentive Auction R&O*, 29 FCC Rcd. at 6762-67, paras. 474-82. A summary of the *Part 1 R&O* was published at 80 Fed. Reg. 56764 (Sep. 18, 2015). All references to the Part 1 and 27 rules adopted by the Commission in the *Part 1 R&O* and cited herein will become effective on the dates announced in the Federal Register summary of the *Part 1 R&O*.

²⁰⁷ Applicants should note that all references to a "winning bid" discussed herein in the context of designated entity bidding credits for Auction 1002 (e.g., the application of a small business discount to an applicant's winning bid) refer to the calculated license price discussed in § IV.C.1 (Calculating Individual License Prices) and set forth in § 9 of Appendix H in Attachment 1 (Forward Auction Assignment Phase and Post-Auction License Prices) to this Public Notice.

²⁰⁸ 47 C.F.R. § 1.2110.

²⁰⁹ 47 C.F.R. § 1.2110(b)(3); *Part 1 R&O*, 30 FCC Rcd at 7502-10, paras. 18-34.

benefits;²¹⁰ (3) updating the gross revenue amounts defining eligibility for small business benefits;²¹¹ (4) creating a separate bidding credit for eligible rural service providers;²¹² and (5) establishing caps on the total amount of designated entity benefits any eligible winning bidder may receive.²¹³

119. In Auction 1002, bidding credits will be available to applicants demonstrating eligibility for a small business or a rural service provider bidding credit and subsequently winning license(s). Bidding credits will not be cumulative—an applicant is permitted to claim either a small business bidding credit or a rural service provider bidding credit, but not both.²¹⁴ Each applicant must also certify that it is eligible for the claimed bidding credit in its FCC Form 175. In addition to the information provided below, each applicant should review carefully the Commission's decisions regarding the designated entity provisions as well as the newly-adopted Part 1 rule changes.²¹⁵

a. Small Business Bidding Credit

120. For Auction 1002, bidding credits will be available to eligible small businesses and consortia thereof, subject to the caps discussed below.²¹⁶ Under the service rules applicable to the 600 MHz Band licenses to be offered in Auction 1002, the level of bidding credit available is determined as follows:

- A bidder with attributed average annual gross revenues that do not exceed \$55 million for the preceding three years is eligible to receive a 15 percent discount on its winning bid.²¹⁷
- A bidder with attributed average annual gross revenues that do not exceed \$20 million for the preceding three years is eligible to receive a 25 percent discount on its winning bid.²¹⁸

121. Small business bidding credits are not cumulative; an eligible applicant may receive either the 15 percent or the 25 percent bidding credit on its winning bid, but not both. The Commission's unjust enrichment provisions also apply to a winning bidder that utilizes a bidding credit and

²¹⁰ 47 C.F.R. § 1.2110(c)(2)(ii)(J); *Part 1 R&O*, 30 FCC Rcd at 7512-16, paras. 42-53. For purposes of this rule, a disclosable interest holder of an applicant seeking designated entity benefits is defined as any individual or entity holding a ten percent or greater interest of any kind in the applicant, including but not limited to, a ten percent or greater interest in any class of stock, warrants, options or debt securities in the applicant or licensee. 47 C.F.R. § 1.2110(c)(2)(ii)(J). The Commission also clarified its designated entity reporting requirements under 47 C.F.R. § 1.2110(n).

²¹¹ 47 C.F.R. § 1.2110(f)(2); *Part 1 R&O*, 30 FCC Rcd at 7523-25, paras. 72-75.

²¹² 47 C.F.R. § 1.2110(f)(4); *Part 1 R&O*, 30 FCC Rcd at 7530-38, paras. 88-108.

²¹³ See 47 C.F.R. § 1.2110(f)(2)(ii), (f)(4)(ii); see also *Part 1 R&O*, 30 FCC Rcd. at 7539-48, paras. 110-130.

²¹⁴ See *Part 1 R&O*, 30 FCC Rcd at 7538, para. 108.

²¹⁵ See *Part 1 R&O*, 30 FCC Rcd 7493; see also, e.g., *Implementation of the Commercial Spectrum Enhancement Act and Modernization of the Commission's Competitive Bidding Rules and Procedures*, WT Docket No. 05-211, Report and Order, FCC 06-4, 21 FCC Rcd 891 (2006) (*CSEA/Part 1 Report and Order*); *Second Report and Order and Second Further Notice of Proposed Rule Making*, FCC 06-52, 21 FCC Rcd 4753 (2006) (*CSEA/Part 1 Second Report and Order*); *Order on Reconsideration of the Second Report and Order*, FCC 06-78, 21 FCC Rcd 6703 (2006) (*CSEA/Part 1 Second Report and Order's First Reconsideration Order*).

²¹⁶ See § III.C.8.c (Caps on Bidding Credits).

²¹⁷ See 47 C.F.R. §§ 1.2110(f)(2)(i)(C), 27.1301(a)(1), (c)(1); *Part 1 R&O*, 30 FCC Rcd 7523-25, paras. 72-75 (superseding the small business size definitions, among other things, that were adopted in the *Incentive Auction R&O*, 29 FCC Rcd. at 6762-63, paras. 474-476).

²¹⁸ See 47 C.F.R. §§ 1.2110(f)(2)(i)(B), 27.1301(a)(2), (c)(1).

subsequently seeks to assign or transfer control of its license within a certain period to an entity not qualifying for the same level of bidding credit.²¹⁹

122. Each applicant claiming a small business bidding credit must disclose the gross revenues for the preceding three years for each of the following: (1) the applicant, (2) its affiliates, (3) its controlling interests, and (4) the affiliates of its controlling interests.²²⁰ The applicant must also submit an attachment that lists all parties with which the applicant has entered into any spectrum use agreements or arrangements for any licenses that be may won by the applicant in Auction 1002.²²¹ In addition, to the extent that an applicant has an agreement with any disclosable interest holder for the use of more than 25 percent of the spectrum capacity of any license that may be won in Auction 1002, the identity and the attributable gross revenues of any such disclosable interest holder must be disclosed.²²² If an applicant is applying as a consortium of small businesses, the disclosures described in this paragraph must be provided for each consortium member.²²³

b. Rural Service Provider Bidding Credit

123. An eligible applicant may request a 15 percent discount on its winning bid using a rural service provider bidding credit, subject to the \$10 million cap discussed below.²²⁴ To be eligible for a rural service provider bidding credit, an applicant must be: (1) a service provider that is in the business of providing commercial communications services and, together with its controlling interests, affiliates, and the affiliates of its controlling interests, has fewer than 250,000 combined wireless, wireline, broadband, and cable subscribers; and (2) serves predominantly rural areas, defined as counties with a population density of 100 or fewer persons per square mile.²²⁵ These eligibility requirements must be satisfied by the FCC Form 175 filing deadline for Auction 1002, i.e., January 28, 2016. Additionally, an applicant may count any subscriber as a single subscriber even if that subscriber receives more than one service.²²⁶

124. Each applicant seeking a rural service provider bidding credit must disclose the number of subscribers it has, along with the number of subscribers of its affiliates, controlling interests, and the affiliates of its controlling interests.²²⁷ The applicant must also submit an attachment that lists all parties with which the applicant has entered into any spectrum use agreements or arrangements for any licenses that be may won by the applicant in Auction 1002.²²⁸ In addition, to the extent that an applicant has an agreement with any disclosable interest holder for the use of more than 25 percent of the spectrum capacity of any license that may be won in Auction 1002, the identity and the attributable subscribers of

²¹⁹ See 47 C.F.R. § 1.2111.

²²⁰ 47 C.F.R. §§ 1.2110(b)(1)(i), 1.2112(b)(1)(iv).

²²¹ See 47 C.F.R. § 1.2112(b)(1)(iii).

²²² This newly-adopted attribution rule is discussed in § III.C.8.d.ii (Limitation on Spectrum Use), and will be applied on a license-by-license basis. See 47 C.F.R. § 1.2110(c)(2)(ii)(J). As a result, an applicant may be eligible for a bidding credit on some, but not all, of the licenses for which it is bidding for in Auction 1002. See *id.*

²²³ 47 C.F.R. §§ 1.2110(b)(4)(i), 1.2110(c)(6), 1.2110(k), 1.2112(b)(1)(vi).

²²⁴ See § III.C.8.c (Caps on Bidding Credits); see also 47 C.F.R. 1.2110(f)(4).

²²⁵ 47 C.F.R. § 1.2110(f)(4)(i). As noted in the *Part 1 R&O*, the Commission declined “to adopt a specific threshold for the proportion of an applicant’s customers who are located in rural areas, but put prospective applicants on notice that it is [the Commission’s] intent that in order for an applicant to be eligible for a rural service provider bidding credit, the primary focus of its business activity must be the provision of services to rural areas.” *Part 1 R&O*, 30 FCC Rcd at 7533, para. 94 n.312.

²²⁶ For instance, a subscriber receiving both wireline and telephone service and broadband would be counted as a single subscriber. *Part 1 R&O*, 30 FCC Rcd at 7534, para. 98 n.326.

²²⁷ See 47 C.F.R. § 1.2112(b)(1)(v); see also 47 C.F.R. § 1.2110(f)(4)(i)(C).

²²⁸ See 47 C.F.R. § 1.2112(b)(1)(iii).

any such disclosable interest holder must be disclosed.²²⁹ Like applicants seeking eligibility for small business bidding credits, eligible rural service providers may also form a consortium.²³⁰ If an applicant is applying as a consortium of rural service providers, the disclosures described in this paragraph, including the certification, must be provided for each consortium member.²³¹

c. Caps on Bidding Credits

125. As noted above, eligible applicants claiming either a small business or rural service provider bidding credit will be subject to certain caps on the total amount of bidding credits that any eligible applicant may receive.²³² Specifically, an applicant claiming a small business bidding credit is subject to a \$150 million aggregate cap, of which at most \$10 million may apply to licenses won in PEAs with a population of 500,000 or less.²³³ Additionally, an applicant claiming a rural service provider bidding credit is subject to a \$10 million aggregate cap.²³⁴ No winning designated entity bidder will be able to obtain more than \$10 million in bidding credits in total for licenses won in PEAs 118-416, with the exception of PEA 412 (Puerto Rico), which exceeds the 500,000 population threshold.²³⁵

d. Attributable Interests

(i) Controlling Interests and Affiliates

126. Pursuant to section 1.2110 of the Commission's rules, an applicant's eligibility for designated entity benefits is determined by attributing the gross revenues (for those seeking small business benefits) or subscribers (for those seeking rural service provider benefits) of the applicant, its affiliates, its controlling interests, and the affiliates of its controlling interests. Controlling interests of an applicant include individuals and entities with either *de facto* or *de jure* control of the applicant. Typically, ownership of greater than 50 percent of an entity's voting stock evidences *de jure* control.²³⁶ *De facto* control is determined on a case-by-case basis based on the totality of the circumstances.²³⁷ The following are some common indicia of *de facto* control:

²²⁹ This newly-adopted attribution rule is discussed in § III.C.8.d.ii (Limitation on Spectrum Use), and will be applied on a license-by-license basis. See 47 C.F.R. § 1.2110(c)(2)(ii)(J). As a result, an applicant may be eligible for a bidding credit on some, but not all, of the licenses for which it is bidding for in Auction 1002. See *id.*

²³⁰ See 47 C.F.R. § 1.2110(b)(4)(i), (c)(6).

²³¹ 47 C.F.R. § 1.2112(b)(1)(vi).

²³² See also § IV.C.1 (Calculating Individual License Prices) and Attachment 1, Appendix H (Forward Auction Assignment and Post-Auction License Prices) to this Public Notice.

²³³ See *Part I R&O*, 30 FCC Rcd at 7544-45, para. 122; see also *Wireless Telecommunications Bureau Provides Details About Partial Economic Areas*, GN Docket No. 12-268, Public Notice, 29 FCC Rcd 6491, App. A at 6491 (2014) (*PEAs PN*). This excludes PEA 412 (Puerto Rico), which has a population of 3.725 million.

²³⁴ *Part I R&O*, 30 FCC Rcd at 7544-48, paras. 122-30; see also § IV.C.1 (Calculating Individual License Prices) and Attachment 1, Appendix H (Forward Auction Assignment Phase and Post-Auction License Prices) to this Public Notice for more information on how the cap will be applied for applicants claiming a designated entity bidding credit.

²³⁵ See *Part I R&O*, 30 FCC Rcd at 7546-48, paras. 127-30. Thus, to the extent an applicant seeking a small business bidding credit does not claim the full \$10 million in bidding credits in those smaller markets, it may apply the remaining balance to its winning bids on licenses in larger markets, up to the aggregate \$150 million cap. See *id.* at 7546, para. 127.

²³⁶ 47 C.F.R. § 1.2110(c)(2).

²³⁷ See *id.*; see also, e.g., *Implementation of Section 309(j) of the Communications Act – Competitive Bidding*, PP Docket No. 93-253, Fifth Memorandum Opinion & Order, FCC 94-285, 10 FCC Rcd 403, 447-49, paras. 80-82, 451, paras. 85-86, 455-56, paras. 95-96 (1994) ("*Fifth MO&O*"); *Intermountain Microwave*, Public Notice, 12 FCC 2d 559 (1963) ("*Intermountain Microwave*"); *Application of Ellis Thompson Corp.*, CC Docket No. 94-136,

(continued....)

- the entity constitutes or appoints more than 50 percent of the board of directors or management committee;
- the entity has authority to appoint, promote, demote, and fire senior executives that control the day-to-day activities of the licensee;
- the entity plays an integral role in management decisions.²³⁸

127. Applicants should refer to section 1.2110(c)(2) of the Commission's rules and the FCC Form 175 Instructions to understand how certain interests are calculated in determining control for purposes of attributing gross revenues. For example, officers and directors of an applicant are considered to have a controlling interest in the applicant.²³⁹

128. Affiliates of an applicant or controlling interest include an individual or entity that (1) directly or indirectly controls or has the power to control the applicant, (2) is directly or indirectly controlled by the applicant, (3) is directly or indirectly controlled by a third party that also controls or has the power to control the applicant, or (4) has an "identity of interest" with the applicant.²⁴⁰ The Commission's definition of an affiliate of the applicant encompasses both controlling interests of the applicant and affiliates of controlling interests of the applicant.²⁴¹ For more information on the application requirements regarding controlling interests and affiliates, applicants should refer to sections 1.2110(c)(2) and (c)(5) respectively, as well as the FCC Form 175 Instructions.²⁴²

129. An applicant seeking a small business bidding credit must demonstrate its eligibility for the bidding credit by: (1) meeting the applicable small business size standard, based on the controlling interest and affiliation rules discussed above, and (2) retaining control, on a license-by-license basis, over the spectrum associated with the licenses for which it seeks small business benefits.²⁴³ For purposes of the first prong of the standard, applicants should note that control and affiliation may arise through, among other things, ownership interests, voting interests, management and other operating agreements, or the terms of any other types of agreements—including spectrum lease agreements—that independently or together create a controlling, or potentially controlling, interest in the applicant's or licensee's business as a whole.²⁴⁴ In addition, once an applicant demonstrates eligibility as a small business under the first prong, it must also be eligible for benefits on a license-by-license basis under the second prong. As part of making the FCC Form 175 certification that it is qualified as a designated entity under section 1.2110, an applicant is certifying that it does not have any spectrum use or other agreements that would confer *de jure* and *de facto* control of any license it seeks to acquire with bidding credits.²⁴⁵

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Memorandum Opinion and Order and Hearing Designation Order, FCC 94-298, 9 FCC Rcd 7138 (1994).

²³⁸ 47 C.F.R. § 1.2110(c)(2)(i)(A)-(C).

²³⁹ 47 C.F.R. § 1.2110(c)(2)(ii)(F).

²⁴⁰ 47 C.F.R. § 1.2110(c)(5).

²⁴¹ *Id.*

²⁴² 47 C.F.R. § 1.2110(c)(2), (c)(5).

²⁴³ See 47 C.F.R. 1.2110(b)(3); see also *Part 1 R&O*, 30 FCC Rcd at 7507-10, paras. 29-34.

²⁴⁴ See 47 C.F.R. § 1.2105(a)(2)(iv); *Part 1 R&O*, 30 FCC Rcd at 7507-09, paras. 29-33; see also, e.g., 47 C.F.R. § 1.2110(c)(5)(vii)-(x) (explaining how affiliation can arise where one concern has the power to control or potentially control the other concern). As discussed below, except under the limited provisions provided for spectrum manager lessors, the Commission's decision to discontinue its policy requiring designated entity licensees to operate as primarily facilities-based providers of service directly to the public does not alter the rules that require the Commission to consider whether any particular use agreement may confer control of or create affiliation with the applicant. See *Part 1 R&O*, 30 FCC Rcd at 7509, para. 33.

²⁴⁵ See 47 C.F.R. § 1.2105(a)(2)(iv); *Part 1 R&O*, 30 FCC Rcd at 7509-10, paras. 33-34; see also 47 C.F.R. § (continued....)

130. Under this new standard for evaluating eligibility for small business bidding credits, if an applicant executes a spectrum use agreement that does not comply with the Commission's relevant standard of *de facto* control,²⁴⁶ it will be subject to unjust enrichment obligations for the benefits associated with that particular license, as well as the penalties associated with any violation of section 310(d) of the Communications Act and related regulations.²⁴⁷ If that spectrum use agreement (either alone or in combination with the designated entity controlling interest and attribution rules described above), goes so far as to confer control of the applicant's overall business, the gross revenues of the additional interest holders will be attributed to the applicant, which could render the applicant ineligible for all current and future small business benefits on all licenses.²⁴⁸

(ii) Limitation on Spectrum Use

131. The Commission determined that a new attribution rule will apply going forward under which the gross revenues (or the subscribers, in the case of a rural service provider) of an applicant's disclosable interest holder are attributable to the applicant, on a license-by-license basis, if the disclosable interest holder has an agreement with the applicant to use, in any manner, more than 25 percent of the spectrum capacity of any license won by the applicant and acquired with a bidding credit during the five-year unjust enrichment period for the applicable license.²⁴⁹ For purposes of this rule, a disclosable interest holder of an applicant seeking designated entity benefits is defined as any individual or entity holding a ten percent or greater interest of any kind in the applicant, including but not limited to, a ten percent or greater interest in any class of stock, warrants, options or debt securities in the applicant or licensee.²⁵⁰ Any applicant seeking a bidding credit for licenses won in Auction 1002 will be subject to this attribution rule and must make the requisite disclosures set forth above.²⁵¹

132. The Commission also determined that certain disclosable interest holders may be excluded from this attribution rule. Specifically, an applicant claiming the rural service provider bidding

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1.2110(c)(2)(ii)(A). For instance, if an applicant has a spectrum use agreement on a particular license that calls into question whether, under the Commission's affiliation rules, the user's revenues should be attributed to the applicant for that particular license, rather than for its overall business operations, the applicant could be ineligible to acquire or retain benefits with respect to that particular license. By taking this license-by-license approach, an applicant need not be eligible for small business benefits on each of the spectrum licenses it holds in order to demonstrate its overall eligibility for such benefits. *Part 1 R&O*, 30 FCC Rcd at 7509, para. 33.

²⁴⁶ See 47 C.F.R. § 1.9010 (*de facto* control for spectrum leasing arrangements); see also *Intermountain Microwave*, 12 FCC 2d at 559-60 (*de facto* control for non-leasing situations); 47 C.F.R. § 1.2110(c)(2) (*de facto* control for designated entities); *Part 1 Fifth Report and Order*, 15 FCC Rcd at 15324, para. 61 (incorporating the *Intermountain Microwave* principles of control into section 1.2110 of the Commission's rules).

²⁴⁷ Although in this scenario the applicant may not be eligible for a bidding credit and may be subject to Commission's unjust enrichment rules, the applicant need not be eligible for small business benefits on each of the spectrum licenses it holds in order to demonstrate its overall eligibility for such benefits.

²⁴⁸ This rule does not alter the requirement of full dilution in 47 C.F.R. § 1.2110(c)(2)(ii)(A). Except where the leasing standard of *de facto* control applies under sections 1.9010 and 1.9020 of the secondary market rules, the criteria of *Intermountain Microwave* and *Ellis Thompson* will continue to apply to every Commission licensee for purposes of assessing whether it can demonstrate that it retains *de facto* control of its business venture and spectrum license. 47 C.F.R. §§ 1.9010, 1.9020; *Application of Ellis Thompson Corporation*, CC Docket No. 94-136, Summary Decision, 10 FCC Rcd 12554, 12555-56, para. 9 (ALJ decision 1995). In the *Part 1 R&O*, the Commission also modified section 1.9020 of its rules so as to apply the same *de facto* control standard to designated entity spectrum manager lessors that is applied to non-designated entity spectrum manager lessors. 47 C.F.R. § 1.9020; *Part 1 R&O*, 30 FCC Rcd at 7510-11, paras. 35-39.

²⁴⁹ See 47 C.F.R. § 1.2110(c)(2)(ii)(J); see also *Part 1 R&O*, 30 FCC Rcd at 7512-16, paras. 42-53.

²⁵⁰ 47 C.F.R. § 1.2110(c)(2)(ii)(J).

²⁵¹ See §§ III.C.8.a (Small Business Bidding Credit) and III.C.8.b (Rural Service Provider Bidding Credit).

credit may have spectrum license use agreements with a disclosable interest holder, without having to attribute the disclosable interest holder's subscribers, so long as the disclosable interest holder is independently eligible for a rural service provider credit and the use agreement is otherwise permissible under the Commission's existing rules.²⁵² If applicable, the applicant must attach to its FCC Form 175 any additional information as may be required to indicate any license (or license area) that may be subject to this attribution rule or to demonstrate its eligibility for the exception from this attribution rule.²⁵³ Consistent with the Commission's limited information procedures, the Bureau intends to withhold from public disclosure all information contained in any such attachments until after the close of the auction.

(iii) Exceptions from Attribution Rules for Small Businesses and Rural Service Providers

133. Applicants claiming designated entity benefits may be eligible for certain exceptions from the Commission's attribution rules.²⁵⁴ For example, the Commission has clarified that, in calculating an applicant's gross revenues under the controlling interest standard, it will not attribute to the applicant the personal net worth, including personal income, of its officers and directors.²⁵⁵ The Commission has also exempted from attribution to the applicant the gross revenues of the affiliates of a rural telephone cooperative's officers and directors, if certain conditions specified in section 1.2110(b)(4)(iii) of the Commission's rules are met.²⁵⁶ An applicant claiming this exemption must provide, in an attachment, an affirmative statement that the applicant, affiliate and/or controlling interest is an eligible rural telephone cooperative within the meaning of section 1.2110(b)(4)(iii), and the applicant must supply any additional information as may be required to demonstrate eligibility for the exemption from the attribution rule.²⁵⁷

134. An applicant claiming a rural service provider bidding credit may be eligible for an exception from the Commission's attribution rules as an existing rural partnership. To qualify for this exception, an applicant must be a rural partnership providing service as of July 16, 2015, and each member of the rural partnership must individually have fewer than 250,000 combined wireless, wireline, broadband, and cable subscribers.²⁵⁸ Because each member of the rural partnership must individually qualify for the bidding credit, by definition, a partnership that includes a nationwide provider as a member will not be eligible for the benefit.²⁵⁹

²⁵² 47 C.F.R. § 1.2110(c)(2)(ii)(J); *Part 1 Report and Order*, 30 FCC Rcd at 7513, para. 46.

²⁵³ To the extent an Auction 1002 applicant is required to submit any such additional information, the applicant must not disclose details of its submission to others as it would reveal information regarding its license area selection(s).

²⁵⁴ See, e.g., 47 C.F.R. § 1.2110(b)(4).

²⁵⁵ See 47 C.F.R. § 1.2110(c)(2)(ii)(F); see also *Part 1 Third R&O Second Recon/Part 1 Fifth R&O Recon*, 18 FCC Rcd at 10185-86, paras. 8-9. However, to the extent that the officers and directors of the applicant are controlling interest holders of other entities, the gross revenues of those entities will be attributed to the applicant. Moreover, if an officer or director operates a separate business, the gross revenues derived from that separate business would be attributed to the applicant, although any personal income from such separate business would not be attributed. See *id.* at 10186, para. 9.

²⁵⁶ *Part 1 Third R&O Second Recon/Part 1 Fifth R&O Recon*, 18 FCC Rcd at 10186-94, paras. 10-18; *Part 1 Fifth R&O Second Recon*, 20 FCC Rcd at 1945-50, paras. 9-18.

²⁵⁷ 47 C.F.R. § 1.2110(b)(4)(iii); see also *Part 1 Third R&O Second Recon/Part 1 Fifth R&O Recon*, 18 FCC Rcd at 10186-95, paras. 10-20; *Part 1 Fifth R&O Second Recon*, 20 FCC Rcd at 1945-50, paras. 9-18.

²⁵⁸ See 47 C.F.R. § 1.2110(f)(4)(i)(C)(2); *Part 1 R&O*, 30 FCC Rcd at 7536, para. 102. Thus, the Bureau will evaluate eligibility for an existing rural wireless partnership on the same basis as it would for an applicant applying for a bidding credit as a consortium of rural service providers. See *Part 1 R&O*, 30 FCC Rcd at 7536, para. 102 n.336.

²⁵⁹ *Part 1 R&O*, 30 FCC Rcd at 7536, para. 103. The Bureau also notes that members of such partnerships that fall
(continued....)

135. Finally, a consortium of small businesses or rural service providers may seek an exception from the Commission's attribution rules. Under the Commission's rules, a consortium of small businesses or rural service providers is a conglomerate organization composed of two or more entities, each of which individually satisfies the definition of small business or rural service provider.²⁶⁰ As set forth above, a consortium must provide additional information for each member demonstrating each member's eligibility for the claimed bidding credit in order to show that the applicant satisfies the eligibility criteria for the bidding credit.²⁶¹ The gross revenue or subscriber information of each consortium member will not be aggregated for purposes of determining the consortium's eligibility for the claimed bidding credit. However, this information must be provided to ensure that each consortium member qualifies for the bidding credit sought by the consortium.

9. Tribal Lands Bidding Credit

136. To encourage the growth of wireless services in federally recognized tribal lands, the Commission has implemented a tribal lands bidding credit.²⁶² Applicants do not provide information regarding tribal lands bidding credits on their FCC Form 175. Instead, winning bidders may apply for the tribal lands bidding credit after the auction when they file their more detailed, FCC Form 601 applications. This process is described in Section IV.C.6 (Tribal Lands Bidding Credit).

10. Provisions Regarding Current and Former Defaulters

137. Pursuant to the rules governing competitive bidding, each applicant must make certifications regarding whether it is a current or former defaulter or delinquent. A current defaulter or delinquent is not eligible to participate in Auction 1002,²⁶³ but a former defaulter or delinquent may participate so long as it is otherwise qualified and, as discussed below,²⁶⁴ makes an upfront payment that is fifty percent more than would otherwise be necessary.²⁶⁵ Accordingly, each applicant must certify

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under this exception may also apply as individual applicants or members of a consortium (to the extent that it is otherwise permissible to do so under the Commission's rules) and seek eligibility for a rural service provider bidding credit. *Part 1 R&O*, 29 FCC Rcd at 7536, paras. 102-103, 7582, para. 210.

²⁶⁰ 47 C.F.R. § 1.2110(c)(6).

²⁶¹ See paragraphs 121 (for small businesses) and 123 (for rural service providers).

²⁶² 47 C.F.R. § 1.2110(f)(3).

²⁶³ An applicant is considered a "current defaulter" or a "current delinquent" when it, any of its affiliates, any of its controlling interests, or any of the affiliates of its controlling interests, is in default on any payment for any Commission construction permit or license (including a down payment) or is delinquent on any non-tax debt owed to any Federal agency as of the filing deadline for auction applications. See *Part 1 Fifth Report and Order*, 15 FCC Rcd at 15317, para. 42 and n.142; *Wireless Telecommunications Bureau Reminds Prospective Broadband PCS Spectrum Auction Applicants of Default and Delinquency Disclosure Requirements*, Public Notice, DA 04-3491, 19 FCC Rcd 21920 (2004) (*Auction Default Disclosure Public Notice*). This public notice may be found at <http://wireless.fcc.gov/auctions/58/>.

²⁶⁴ See § III.D.4 (Upfront Payment and Bidding Eligibility).

²⁶⁵ 47 C.F.R. §§ 1.2105(a)(2)(xii), 1.2105(b)(1), and 1.2106(a). For purposes of evaluating the certifications under section 1.2105(a)(2)(xi) and (xii), we clarify that "non-tax debt owed to any Federal agency" includes, within the meaning of the rule, all amounts owed under Federal programs, including contributions to the Universal Service Fund, Telecommunications Relay Services Fund, and the North American Numbering Plan Administration, notwithstanding that the administrator of any such fund may not be considered a Federal "agency" under the Debt Collection Improvement Act of 1996. Pub. L. No. 104-134, 110 Stat. 1321 (1996) (codified in relevant parts at 31 U.S.C. §§ 3716 (administrative offset) and 3717 (interest and penalty on claims)); see also 47 C.F.R. §§ 1.1901, 1.1911, 1.1912, 1.1940. For example, an applicant with a past due USF contribution as of the auction application filing deadline would be disqualified from participating in Auction 1002 under the Commission's rules. 47 C.F.R. § 1.2105(a)(2)(xi) and (b)(1). If, however, the applicant cures the overdue debt prior to the auction application filing deadline (and such debt does not fall within one of the exclusions described in paragraph 137 of this Public Notice, (continued....)

under penalty of perjury on its FCC Form 175 that it, its affiliates, its controlling interests, and the affiliates of its controlling interests, are not in default on any payment for a Commission construction permit or license (including down payments) and that it is not delinquent on any non-tax debt owed to any Federal agency.²⁶⁶ Additionally, an applicant must certify under penalty of perjury whether it (along with its controlling interests) has ever been in default on any payment for a Commission construction permit or license (including down payments) or has ever been delinquent on any non-tax debt owed to any Federal agency, subject to the exclusions described below.²⁶⁷ For purposes of making these certifications, the term “controlling interest” is defined in section 1.2105(a)(4)(i) of the Commission rules.²⁶⁸

138. Under the Commission’s revised rule regarding applications by former defaulters, an applicant is considered a “former defaulter” or a “former delinquent” when, as of the FCC Form 175 deadline, it or any of its controlling interests has defaulted on any Commission construction permit or license or has been delinquent on any non-tax debt owed to any Federal agency, but has since remedied all such defaults and cured all of the outstanding non-tax delinquencies.²⁶⁹ For purposes of the certification under section 1.2105(a)(2)(xii), the applicant may exclude from consideration any cured default on a Commission license or delinquency on a non-tax debt owed to a Federal agency for which any of the following criteria are met: (1) the notice of the final payment deadline or delinquency was received more than seven years before the FCC Form 175 filing deadline; (2) the default or delinquency amounted to less than \$100,000; (3) the default or delinquency was paid within two quarters (i.e., six months) after receiving the notice of the final payment deadline or delinquency; or (4) the default or delinquency was the subject of a legal or arbitration proceeding and was cured upon resolution of the proceeding.²⁷⁰ With respect to the first exclusion, notice to a debtor may include notice of a final payment

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it may be eligible to participate in Auction 1002 as a former defaulter under the Commission’s rules. 47 C.F.R. §§ 1.2105(a)(2)(xii), 1.2106(a).

²⁶⁶ See 47 C.F.R. 1.2105(a)(2)(xi); *Part 1 Fifth Report and Order*, 15 FCC Rcd at 15317, para. 42 and n.142 (“If any one of an applicant’s controlling interests or their affiliates . . . is in default on any Commission licenses or is delinquent on any non-tax debt owed to any Federal agency at the time the applicant files it[s] FCC Form 175, the applicant will not be able to make the certification required by section 1.2105(a)(2)(x). . . and will not be eligible to participate in Commission auctions.”).

²⁶⁷ 47 C.F.R. §§ 1.2105(a)(2)(xii).

²⁶⁸ 47 C.F.R. § 1.2105(a)(4)(i).

²⁶⁹ The Commission recently narrowed the scope of the individuals and entities to be considered for purposes of the former defaulter rule. See 47 C.F.R. § 1.2105(a)(2)(xii), (a)(4); see also *Part 1 R&O*, 30 FCC Rcd at 7568, para. 175.

²⁷⁰ Additionally, for purposes of the certification required on an FCC Form 175, a debt will not be deemed to be in default or delinquent until after the expiration of a final payment deadline. See, e.g., Letter to Cheryl A. Tritt, Esq., from Margaret W. Wiener, Chief, Auctions and Spectrum Access Division, Wireless Telecommunications Bureau, 19 FCC Rcd 22907 (2004) (*Cheryl A. Tritt Letter*). Thus, to the extent that the rules providing for payment of a specific federal debt permit payment after an original payment deadline accompanied by late fee(s), such debts would not be in default or delinquent for purposes of applying the former defaulter rules until after the late payment deadline. In addition, the Bureau provides the following clarification with regard to defaults on Commission licenses. Any winning bidder that fails timely to pay its post-auction down payment or the balance of its final winning bid amount(s) or is disqualified for any reason after the close of an auction will be in default and subject to a default payment. See 47 C.F.R. § 1.2109(c). Commission staff provide individual notice of the amount of such a default payment as well as procedures and information required by the Debt Collection Improvement Act of 1996, including the payment due date and any charges, interest, and/or penalties that accrue in the event of delinquency. See, e.g., 31 U.S.C. §§ 3716, 3717; 47 C.F.R. §§ 1.1911, 1.1912, 1.1940. See also *Auction of Advanced Wireless Services (AWS-3) Licenses Closes; Winning Bidders Announced for Auction 97*, Public Notice, DA 15-131, 30 FCC Rcd 630, 634-35, paras. 21-25 (2015). For purposes of the certifications required on an FCC Form 175, such notice provided by Commission staff assessing a default payment arising out of a default on a winning bid, constitutes notice of the final payment deadline with respect to a default on a Commission license.

deadline or notice of delinquency and may be express or implied depending on the origin of any Federal non-tax debt giving rise to a default or delinquency.²⁷¹ Additionally, for the third exclusion, the date of receipt of the notice of a final default deadline or delinquency by the intended party or debtor will be used for purposes of verifying receipt of notice.²⁷²

139. In addition to this Public Notice, applicants are encouraged to review the Bureau's previous guidance on default and delinquency disclosure requirements in the context of the auction application process.²⁷³ Parties are also encouraged to consult with the Bureau's Auctions and Spectrum Access Division staff if they have any questions about default and delinquency disclosure requirements.

140. The Commission considers outstanding debts owed to the United States Government, in any amount, to be a serious matter. The Commission adopted rules, including a provision referred to as the "red light rule," that implement its obligations under the Debt Collection Improvement Act of 1996, which governs the collection of debts owed to the United States.²⁷⁴ Under the red light rule, applications and other requests for benefits filed by parties that have outstanding debts owed to the Commission will not be processed. In the same rulemaking order, the Commission explicitly declared, however, that its competitive bidding rules "are not affected" by the red light rule.²⁷⁵ As a consequence, the Commission's adoption of the red light rule does not alter the applicability of any of its competitive bidding rules, including the provisions and certifications of sections 1.2105 and 1.2106, with regard to current and former defaults or delinquencies.

141. The Bureau reminds each applicant, however, that the Commission's Red Light Display system, which provides information regarding debts currently owed to the Commission, may not be determinative of an auction applicant's ability to comply with the default and delinquency disclosure requirements of section 1.2105.²⁷⁶ Thus, while the red light rule ultimately may prevent the processing of post-auction applications by auction winners, an auction applicant's lack of current "red light" status is not necessarily determinative of its eligibility to participate in an auction or of its upfront payment obligation. Moreover, a prospective applicant in Auction 1002 should note that any post-auction application filed after the close of bidding will be reviewed for compliance with the Commission's red light rule,²⁷⁷ and such review may result in the dismissal of a winning bidder's post-auction application.²⁷⁸ We strongly encourage each applicant (including its affiliates, controlling interests, and the affiliates of its controlling interests) to carefully review all records and other federal agency databases and information

²⁷¹ *Part 1 R&O*, 30 FCC Rcd at 7566, para.173 n.556.

²⁷² *See id.* at 7567, para. 173 n.559.

²⁷³ *Auction Default Disclosure Public Notice*, 19 FCC Rcd 21920. *See also Part 1 Fifth Report and Order*, 15 FCC Rcd at 15316-17, paras. 41-42; *Cheryl A. Tritt Letter*, 19 FCC Rcd 22907.

²⁷⁴ *Amendment of Parts 0 and 1 of the Commission's Rules; Implementation of the Debt Collection Improvement Act of 1996 and Adoption of Rules Governing Applications or Requests for Benefits by Delinquent Debtors*, MD Docket No. 02-339, Report and Order, FCC 04-72, 19 FCC Rcd 6540 (2004) (implementing Pub. L. No. 104-134, 110 Stat. 1321(1996)) (*Debt Collection Report and Order*).

²⁷⁵ *Debt Collection Report and Order*, 19 FCC Rcd at 6541 n.11 (specifically noting the former defaulter and current defaulter certifications (47 C.F.R. §§ 1.2105(a)(2)(xi) and (xii) respectively) and stating that "[t]hese rules are not affected by the red light rule.")

²⁷⁶ *Auction Default Disclosure Public Notice*, 19 FCC Rcd at 2191-22 (addressing relationship between Commission's Red Light Display system and FCC Form 175 default and delinquency disclosure requirements for auction applicants). To access the Commission's Red Light Display system, go to: <https://apps.fcc.gov/redlight/login.cfm>.

²⁷⁷ *Debt Collection Report and Order*, 19 FCC Rcd at 6541-42, paras. 3-5; *see* 47 C.F.R. § 1.1114.

²⁷⁸ Applicants that have their FCC Form 601 dismissed will be deemed to have defaulted and will be subject to default payments under 47 C.F.R. §§ 1.2104(g) and 1.2109(c).

sources available to it to determine whether the applicant owes or was ever delinquent in the payment of non-tax debt owed to any federal agency.

11. Optional Applicant Status Identification

142. Applicants owned by members of minority groups and/or women, as defined in section 1.2110(c)(3),²⁷⁹ and rural telephone companies, as defined in section 1.2110(c)(4),²⁸⁰ may identify themselves regarding this status in filling out their FCC Form 175 applications. This applicant status information is collected for statistical purposes only and assists the Commission in monitoring the participation of various groups in its auctions.²⁸¹

12. Modifications to FCC Form 175

a. Only Minor Modifications Allowed

143. After the initial FCC Form 175 filing deadline, an Auction 1002 applicant will be permitted to make only minor changes to its application. Examples of minor changes include the deletion or addition of authorized bidders (to a maximum of three), revision of addresses and telephone numbers of the applicant, its responsible party, and its contact person, and change in the applicant's selected bidding option (electronic or telephonic). Major modification to an FCC Form 175 application (e.g., change of license area selection, change in ownership that would constitute an assignment or transfer of control of the applicant, change of certifying official, change in applicant's legal classification that results in a change in control, or change in claimed eligibility for a higher percentage of bidding credit) will not be permitted after the initial FCC Form 175 filing deadline.²⁸² If an applicant makes a "major amendment," as defined by section 1.2105(b)(2), the major amendment will not be accepted and may result in the dismissal of the application.²⁸³

b. Duty to Maintain Accuracy and Completeness of FCC Form 175

144. Each applicant has a continuing obligation to maintain the accuracy and completeness of information furnished in its pending application, including a pending application in a competitive bidding proceeding.²⁸⁴ An Auction 1002 applicant must furnish additional or corrected information to the

²⁷⁹ 47 C.F.R. § 1.2110(c)(3).

²⁸⁰ 47 C.F.R. § 1.2110(c)(4).

²⁸¹ For instance, designated entities are defined as small businesses (including businesses owned by members of minority groups and/or women), rural telephone companies, and rural service providers. 47 C.F.R. § 1.2110(a).

²⁸² See 47 C.F.R. § 1.2105(b)(2); see also *Two Way Radio of Carolina, Inc., Memorandum Opinion and Order*, FCC 99-189, 14 FCC Rcd 12035 (1999) (*Two Way Radio*) (auction applicant not allowed to change its designated entity status after application filing deadline).

²⁸³ See 47 C.F.R. § 1.2105(b)(2). Any change in control of an applicant—resulting from a merger, for example—will be considered a major modification, and the application will consequently be dismissed. The Bureau reiterates that, even if an applicant's FCC Form 175 is dismissed, the applicant would remain subject to the communication prohibitions of 47 C.F.R. § 1.2105(c) until the down-payment deadline, which will be established after the auction closes.

²⁸⁴ See 47 C.F.R. §§ 1.65 and 1.2105(b)(4). For purposes of sections 1.65 and 1.2105(b)(4), an applicant's FCC Form 175 and associated exhibits will remain pending until the release of the *Channel Reassignment PN*. However, the Bureau reminds Auction 1002 applicants that they remain subject to the section 1.2105(c) prohibition on certain communications until the post-auction deadline for making down payments on winning bids. See *Prohibited Communications PN*, DA 15-1129 at 10-11, paras. 25-26, 16, para. 45. An applicant's post-auction application (FCC Form 601) is considered pending from the time it is accepted for filing by the Commission until a Commission grant or denial of the application is no longer subject to reconsideration by the Commission or to review by any court. See 47 C.F.R. § 1.65.

Commission within five days after a significant occurrence,²⁸⁵ or amend its FCC Form 175 no more than five days after the applicant becomes aware of the need for the amendment.²⁸⁶ Changes that cause a loss of or reduction in the percentage of bidding credit specified on the originally-submitted application must be reported immediately, and no later than five business days after the change occurs. An applicant's obligation to make modifications to a pending application in order to provide additional or corrected information continues in accordance with the Commission's rules.²⁸⁷ The Bureau notes that an applicant is obligated to amend its pending application even if a reported change is considered to be a major modification that may result in the dismissal of its application.

c. Submitting Modifications to FCC Form 175

145. If an applicant needs to make permissible minor changes to its FCC Form 175, or must make changes in order to maintain the accuracy and completeness of its application pursuant to sections 1.65 and 1.2105(b)(4), during a time when the system is available to the applicant for purposes of making the type of change(s) required, such changes should be made electronically to its FCC Form 175 using the Auction System. For the change to be submitted and considered by the Commission, an applicant must click on the SUBMIT button. After the revised application has been submitted, a confirmation page will be displayed stating the submission time, submission date, and a unique file number.²⁸⁸

146. An applicant cannot use the Auction System outside of the initial and resubmission filing windows to make changes to its FCC Form 175 for other than administrative changes (e.g., changing responsible party or contact person name and related information, adding or deleting an authorized bidder). If other permissible minor changes need to be made, or if changes are required pursuant to sections 1.65 and 1.2105(b)(4), outside of these filing windows, the applicant must submit a letter briefly summarizing the changes to its FCC Form 175 by e-mail to auction1002@fcc.gov. The e-mail summarizing the changes must include a subject or caption referring to Auction 1002 and the name of the applicant, for example, "Re: Changes to Auction 1002 Application of XYZ Corp." Any attachments to e-mail must be formatted as Adobe® Acrobat® (PDF) or Microsoft® Word documents. Questions about FCC Form 175 amendments should be directed to the Auctions and Spectrum Access Division at (202) 418-0660. An applicant that submits its changes in this manner must subsequently update its FCC Form 175 application in the Auction System once it is open and available to applicants. Moreover, after the initial filing window has closed, the Auction System will not permit an applicant to make certain permissible changes itself (e.g., correcting a misstatement of the applicant's legal classification, reducing the applicant's claimed bidding credit level).²⁸⁹ If an applicant needs to make a permissible minor change that cannot be made using the Auction System, it must submit a written request by e-mail to the auction1002@fcc.gov mailbox requesting that the Commission manually make the change on the applicant's behalf. The applicant must then recertify and resubmit its application by clicking on the SUBMIT button to confirm the change.

147. As with the FCC Form 175, any application amendment and related statements of fact must be certified by an authorized representative of the applicant with authority to bind the applicant. Applicants should note that submission of any such amendment or related statement of fact constitutes a

²⁸⁵ The Bureau reminds each applicant of its duty to continuously maintain the accuracy of information submitted in its auction application. *See, e.g., Vermont Telephone Company, Notice of Apparent Liability for Forfeiture*, 26 FCC Rcd 14130 (Enf. 2011).

²⁸⁶ 47 C.F.R. §§ 1.65, 1.2105(b)(4). *See also Procedural Amendments to Commission Part 1 Competitive Bidding Rules*, WT Docket No. 10-18, Order, FCC 10-4, 25 FCC Rcd 521, 523, para. 8 (2010).

²⁸⁷ *See* 47 C.F.R. §§ 1.65 and 1.2105(b)(4).

²⁸⁸ The Bureau advises applicants to retain a copy of this confirmation page.

²⁸⁹ This is the case because certain fields on the FCC Form 175 will no longer be available to, or changeable by, the applicant after the initial application filing window closes.

representation by the person certifying that he or she is an authorized representative with such authority, and that the contents of the amendment or statement of fact are true and correct.

148. Applicants must not submit application-specific material through the Commission's Electronic Comment Filing System. Further, as discussed in the *Prohibited Communications PN*, parties submitting information related to their applications should use caution to ensure that their submissions do not contain confidential information or communicate information that would violate section 1.2105(c) or the limited information procedures adopted for Auction 1002.²⁹⁰ A party seeking to submit, outside of the Auction System, information that might reflect non-public information, such as an applicant's license area selections, upfront payment amount, or bidding eligibility, should consider submitting any such information along with a request that the filing or portions of the filing be withheld from public inspection until the end of the prohibition of certain communications period pursuant to section 1.2105(c).

D. Auction 1002 Process

1. Online Auction Tutorials and Training

149. Online auction tutorials will be available on the Auction 1002 web page for prospective bidders to familiarize themselves with the forward auction application and bidding processes. The online tutorials will provide information about pre-auction procedures, completing auction applications, auction conduct, the Auction System, auction rules, and 600 MHz Band service rules. Specifically, the first auction tutorial will focus on the auction application process and the second tutorial will focus on the bidding process. Both tutorials will also provide an avenue to ask Commission staff questions about the auction, auction procedures, filing requirements, and other matters related to the forward auction. The tutorials will allow viewers to navigate the presentation outline, review written notes, listen to audio recordings of the notes, and search for topics using a text search function. Additional features of this web-based tool include links to auction-specific Commission releases, e-mail links for contacting Commission licensing and auctions staff, and screen shots of the online application and Auction System. Using a web browser with Adobe Flash Player,²⁹¹ the tutorials will be accessible from the Commission's Auction 1002 web page at <http://www.fcc.gov/auctions/1002> through an "Auction Tutorial" link under the "Education" tab.²⁹² The application tutorial will be available on the Auction 1002 web page under the "Education" tab on January 7, 2016, and the bidding process tutorial will be available on February 29, 2016. Once posted, the tutorials will remain available and accessible anytime for reference in connection with the procedures outlined in this Public Notice. In addition, an Auction 1002 applicant whose application has been deemed to be "complete"²⁹³ will be provided with additional opportunities to gain knowledge and experience with the auction bidding system prior to the mock auction that will be offered to qualified bidders. Based on our experience with past auctions, parties interested in participating in this auction will find the interactive, online tutorials an efficient and effective way to further their understanding of the auction process.

2. FCC Form 175 – Due Prior to 6:00 p.m. ET on January 28, 2016

150. In order to be eligible to bid in the forward auction, applicants must first follow the procedures set forth in the FCC Form 175 Instructions to submit an FCC Form 175 electronically via the Auction System.²⁹⁴

²⁹⁰ See *Prohibited Communications PN* at 15, para. 42.

²⁹¹ Most users will already have the Flash Player browser plug-in, which can be downloaded from <http://get.adobe.com/flashplayer/>.

²⁹² Alternatively, the Auction 1002 website can be accessed by going to <http://www.fcc.gov/auctions/1002>.

²⁹³ See § III.D.3.a (Public Notice of Applicants' Initial Application Status and Opportunity for Minor Corrections).

²⁹⁴ 47 C.F.R. § 1.2105(a).

151. An applicant may file its application to participate in Auction 1002 during the filing window that will begin at noon ET on January 14, 2016 and close at 6:00 p.m. ET on January 28, 2016. The application must be submitted **prior to** the closing of the filing window. **Late applications will not be accepted.** No application fee is required, but an applicant must submit a timely upfront payment to be eligible to bid.²⁹⁵ Applicants are strongly encouraged to file early and are responsible for allowing adequate time for filing their applications. There are no limits or restrictions on the number of times an application can be updated or amended until the filing deadline on January 28, 2016.

152. An applicant must always click on the SUBMIT button on the “Certify & Submit” screen to successfully submit its FCC Form 175 and any modifications; otherwise the application or changes to it will not be received or reviewable by Commission staff. Additional information about accessing, completing, and viewing the FCC Form 175 will be included in the FCC Form 175 Instructions. FCC Auctions Technical Support is available at (877) 480-3201, option nine; (202) 414-1250; or (202) 414-1255 (TTY); hours of service are Monday through Friday, from 8:00 a.m. to 6:00 p.m. ET. In order to provide better service to the public, all calls to Technical Support are recorded.

3. Application Processing and Minor Corrections

a. Public Notice of Applicants’ Initial Application Status and Opportunity for Minor Corrections

153. After the deadline for filing auction applications, the Bureau will process all timely submitted applications to determine which are complete, and subsequently will issue a public notice with applicants’ initial application status identifying (1) those that are complete, (2) those that are rejected, and (3) those that are incomplete or deficient because of minor defects that may be corrected. The public notice will include the deadline for resubmitting corrected applications.

154. As described above, after the application filing deadline on January 28, 2016, applicants can make only minor corrections to their applications.²⁹⁶ Major modifications (e.g., change license selection, change control of the applicant, change the certifying official, or claim eligibility for a higher percentage of bidding credit) will not be permitted.²⁹⁷

155. Commission staff will communicate only with an applicant’s contact person or certifying official, as designated on the applicant’s FCC Form 175, unless the applicant’s certifying official or contact person notifies Commission staff in writing that another representative is authorized to speak on the applicant’s behalf.²⁹⁸ Authorizations may be sent by e-mail to auction1002@fcc.gov.

b. Public Notice of Applicants’ Final Application Status After Upfront Payment Deadline

156. The *Auction 1002 Qualified Bidders PN* will be issued at least 15 business days before bidding in the initial stage of Auction 1002 begins.²⁹⁹ Qualified bidders are those applicants with submitted FCC Form 175 applications that are deemed timely-filed and complete, provided that such applicants have timely submitted an upfront payment that is sufficient to qualify them to bid.³⁰⁰

²⁹⁵ See § III.D.4 (Upfront Payments and Bidding Eligibility).

²⁹⁶ See § III.C.12 (Modifications to FCC Form 175).

²⁹⁷ 47 C.F.R. § 1.2105(b); *see also Two Way Radio*, 14 FCC Rcd at 12035.

²⁹⁸ In no event, however, will the Commission send auction registration materials to anyone other than the contact person listed on the applicant’s FCC Form 175 or respond to a request for replacement registration materials from anyone other than the authorized bidder, contact person, or certifying official listed on the applicant’s FCC Form 175. See § III.D.5 (Auction Registration).

²⁹⁹ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9042-43, para. 133.

³⁰⁰ See *id.* at 9027, para. 89.

4. Upfront Payments and Bidding Eligibility

157. In order to be eligible to bid in Auction 1002, an applicant must submit an upfront payment. An upfront payment is a refundable deposit made by each bidder to establish its eligibility to bid on licenses. Upfront payments help deter frivolous or insincere bidding, and provide the Commission with a source of funds in the event that the bidder incurs liability during the auction. Upfront payments will be due after the initial clearing target and associated band plan scenario has been determined.³⁰¹ The deadline for submitting upfront payments for Auction 1002, as well as detailed instructions about submitting upfront payments, will be provided in the *Upfront Payment PN*.

158. The amount of the upfront payment will determine a bidder's initial bidding eligibility in terms of bidding units, i.e., the maximum number of blocks, as measured by their associated bidding units, a bidder may demand in the clock phase of the forward auction. In order to bid for blocks in a particular PEA, a qualified bidder must have selected that PEA on its FCC Form 175 and must have a current eligibility level that meets or exceeds the number of bidding units assigned to the blocks in that PEA multiplied by the number of blocks for which it wishes to bid. At a minimum, an applicant's total upfront payment must be enough to establish eligibility to bid on at least one block in one of the PEAs selected on its FCC Form 175 for Auction 1002, or else the applicant will not be eligible to bid in the auction. In addition, each applicant should check its calculations carefully, as there is no provision for increasing a bidder's eligibility after the upfront payment deadline.³⁰² An applicant does not have to make an upfront payment to cover all of the blocks in all of the license areas the applicant selected on its FCC Form 175, but only enough to cover the maximum number of bidding units that are associated with the blocks in the license area(s) on which it wishes to bid in any round.³⁰³ The total upfront payment does not affect the prices at which the bidder may demand blocks, nor the bidder's dollar commitment associated with the bidder's total demands at any point in the auction.

159. The Commission adopted an upfront payment amount of \$2,500 per bidding unit for Auction 1002.³⁰⁴ The number of bidding units assigned to the spectrum blocks in each PEA, calculated using the approach adopted by the Commission in the *Auction 1000 Bidding Procedures PN*,³⁰⁵ is set forth in Attachment 1, Appendix F (Forward Auction Bidding Units, Upfront Payments, and Minimum Opening Bids) to this Public Notice. The number of bidding units for the blocks in a given PEA will be fixed and will not change during the auction, regardless of price changes.³⁰⁶ The specific minimum opening bids and upfront payments for the forward auction are set forth in Attachment 1, Appendix F to this Public Notice.

160. Applicants considered to be former defaulters under the Commission's rules³⁰⁷ must make upfront payments that are 50 percent greater than non-former defaulters.³⁰⁸ For purposes of this calculation, an "applicant" includes the applicant itself and its controlling interests, as defined in sections 1.2105 and 1.2110 of the Commission's rules.³⁰⁹ If an applicant is a former defaulter, it must calculate its

³⁰¹ See *id.* at 9025-26, para. 84.

³⁰² As noted in the *Auction 1000 Bidding Procedures PN*, in Auction 1002, we do not provide for activity rule waivers to preserve a bidder's eligibility. See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9077 para. 213.

³⁰³ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9026, para. 86.

³⁰⁴ See *id.* at 9025, para. 81.

³⁰⁵ See *id.* at 9023-25, paras. 76-81.

³⁰⁶ See *id.* at 9024, para. 78.

³⁰⁷ See 47 C.F.R. § 1.2105(a)(2)(xii); see also *Part 1 R&O*, 30 FCC Rcd at 7566-67, para. 173.

³⁰⁸ See 47 C.F.R. § 1.2106(a); *Part 1 Fifth Report and Order*, 15 FCC Rcd at 15316-17, paras. 40-42; see also § III.C.10 (Provisions Regarding Current and Former Defaulters).

³⁰⁹ See 47 C.F.R. §§ 1.2105(a)(2)(xii), (a)(4)(i), 1.2110(c).

upfront payment for all of its identified licenses by multiplying the number of bidding units on which it wishes to be active by 1.5.³¹⁰ In order to calculate the number of bidding units to assign to former defaulters, the Commission will divide the upfront payment received by 1.5 and round the result up to the nearest bidding unit.³¹¹

5. Auction Registration

161. All qualified bidders listed in the *Auction 1002 Qualified Bidders PN* will be automatically registered for the auction. Registration materials will be distributed prior to the auction by overnight mail.³¹² The mailing will be sent only to the contact person at the contact address listed in the FCC Form 175 application and will include the SecurID® tokens that will be required to place bids, the “Auction System Bidder’s Guide,” and the Auction Bidder Line phone number.

162. Qualified bidders that do not receive this registration mailing will not be able to submit bids. Therefore, if this mailing is not received by noon five days prior to the mock auction, call the Auctions Hotline at (717) 338-2868. Receipt of this registration mailing is critical to participating in the auction, and each applicant is responsible for ensuring it has received all of the registration material.

163. In the event that SecurID® tokens are lost or damaged, only a person who has been designated as an authorized bidder, the contact person, or the certifying official on the applicant’s FCC Form 175 may request replacements. To request replacement of these items, call Technical Support at (877) 480-3201, option nine; (202) 414-1250; or (202) 414-1255 (TTY).

6. Remote Electronic Bidding

164. The Commission will conduct this auction over the Internet, and telephonic bidding will be available as well. Only qualified bidders are permitted to bid. Each applicant should indicate its bidding preference—electronic or telephonic—on its FCC Form 175. In either case, each authorized bidder must have its own designated SecurID® token, which the Commission will provide at no charge. Each authorized bidder will be issued a unique SecurID® token. For security purposes, the SecurID® tokens, the telephonic bidding telephone number, and the “Auction System Bidder’s Guide” are only mailed to the contact person at the contact address listed on the FCC Form 175. Each SecurID® token is tailored to a specific auction and designated authorized bidder. SecurID® tokens issued for other auctions or obtained from a source other than the Commission will not work for Auction 1002. All telephone calls are recorded.

165. Please note that the SecurID® tokens can be recycled, and the Bureau encourages bidders to return the tokens to the Commission. Pre-addressed envelopes will be provided to return the tokens once bidding has closed.

7. Mock Auction – Clock and Assignment Phases

166. All Auction 1002 qualified bidders will be eligible to participate in a mock auction prior to bidding in Auction 1002. This mock auction will enable bidders to become familiar with the ascending clock auction format and assignment phase bidding using the Auction System prior to the start of the

³¹⁰ See 47 C.F.R. § 1.2106(a).

³¹¹ If a former defaulter fails to submit a sufficient upfront payment to establish eligibility to bid on at least one block in one of the PEAs it selected on its FCC Form 175, the applicant will not be eligible to participate in the forward auction. This applicant will retain its status as an applicant in Auction 1002 for purposes of the prohibition on certain communications in 47 C.F.R. § 1.2105(c). See *Star Wireless and Northeast Communications of Wisconsin, Inc.*, Order on Review, 22 FCC Rcd 8943, 8947-48, paras. 8-9.

³¹² As noted in the *Auction 1000 Bidding Procedures PN*, forward auction qualified bidders will have access to detailed impairment information, including the actual source and location of any impairment, upon receipt of their registration materials. See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9043-44, para. 134.

auction. The Bureau strongly recommends that all bidders participate in the mock auction. The date for the mock auction will be announced in *Auction 1002 Qualified Bidders PN*.

IV. POST-AUCTION PROCESS

A. Channel Reassignment PN

167. Following completion of the reverse and forward auctions,³¹³ the Media and Wireless Telecommunications Bureaus will announce the results of the incentive auction and the repacking process in the *Channel Reassignment PN*.³¹⁴ Specifically, the *Channel Reassignment PN* will provide the results of the reverse auction, the forward auction and the repacking, indicating the reassignments of television channels and reallocations of broadcast television spectrum.³¹⁵ The *Channel Reassignment PN* will also establish the beginning of a 39-month post-auction transition period.³¹⁶ Finally, the *Channel Reassignment PN* will provide additional details relating to post-auction procedures for successful bidders in the reverse and forward auctions, respectively.

B. Incentive Payments to Reverse Auction Winning Bidders

1. Payees and Transmittal

168. Incentive payments will be disbursed from the proceeds received in the forward auction.³¹⁷ A successful bidder in the reverse auction must submit the necessary financial information via a standardized incentive payment form to facilitate the disbursement of its incentive payment.³¹⁸ Specific procedures for submitting the form, including applicable deadlines, will be set forth in the *Channel Reassignment PN*. As noted in the *Incentive Auction R&O*, the Commission intends to follow winning reverse auction bidders' payment instructions as set forth on their respective standardized incentive payment forms to the extent permitted by applicable law.³¹⁹

2. Time of Payment

169. The Commission will share auction proceeds with broadcasters relinquishing spectrum usage rights as soon as practicable following the successful conclusion of the incentive auction.³²⁰ As explained in the *Incentive Auction R&O*, the Commission may disburse auction proceeds only after spectrum licenses associated with winning forward auction bids have been granted, absent express statutory direction to do otherwise.³²¹ The Commission typically grants spectrum licenses after an auction

³¹³ The Commission determined in the *Incentive Auction R&O* that the reverse and forward auctions will be "complete" when a public notice announces that each auction, respectively, has ended. *Incentive Auction R&O*, 29 FCC Rcd at 6783–84, para. 529; 47 C.F.R. § 1.2208.

³¹⁴ *Incentive Auction R&O*, 29 FCC Rcd at 6782, para. 525.

³¹⁵ 47 C.F.R. § 73.3700(a)(2).

³¹⁶ *Id.* § 27.4.

³¹⁷ See *Incentive Auction R&O*, 29 FCC Rcd at 6787–88, para. 538.

³¹⁸ 47 C.F.R. § 1.2209; *Incentive Auction R&O*, 29 FCC Rcd at 6787, para. 537.

³¹⁹ *Incentive Auction R&O*, 29 FCC Rcd at 6787, para. 537 n.1529. See also LocusPoint Networks, LLC Comments at 13–14 (proposing that the Commission should allow participating licensees to specify the accounts into which their payments are to be deposited and not limit the permissible accounts to those owned by the licensee).

³²⁰ The Spectrum Act does not specify a timetable for the distribution of auction proceeds, though it specifies some deadlines before which particular distributions must occur. See generally 47 U.S.C. § 309(j)(8)(G)(iii). See *id.* §§ 309(j)(8)(G)(iii)(II) (setting a deadline for making deposits of remaining incentive auction proceeds before the end of fiscal year 2022 into the Public Safety Trust Fund ("PSTF") and after the end of fiscal year 2022 into the Treasury general fund), 1452(d)(4) (setting a deadline for the transfer of unused funds in the TV Broadcaster Relocation Fund three years after the completion of the forward auction).

³²¹ *Incentive Auction R&O*, 29 FCC Rcd at 6786, para. 534.

on a rolling basis, as license applications filed by winning bidders are ready to be granted.³²² Likewise, incentive auction proceeds will become available for distribution on a rolling basis over time and at intervals tied to the forward auction licensing process. Consequently, we cannot at this point set a specific deadline for sharing incentive auction proceeds.³²³

170. The Commission is committed to disbursing auction proceeds as promptly as possible while meeting all of its statutory responsibilities.³²⁴ As the Commission noted in the *Auction 1000 Comment PN*, circumstances regarding the post-auction transition process for broadcasters may make it in the public interest to prioritize payments to some broadcasters over others in order to expedite the entire post-auction transition process.³²⁵ The Commission may take factors that facilitate the transition process into account when determining the sequence of payments sharing auction proceeds.

C. Forward Auction Participants

171. As discussed above, shortly after bidding has ended, the *Channel Reassignment PN* will be issued declaring the auction closed, identifying the winning bidders and the total amount that they will owe,³²⁶ and establishing the deadlines for submitting down payments, final payments, post-auction applications, and ownership disclosure information reports.³²⁷

1. Calculating Individual License Prices

172. In order to calculate individual license prices, the auction system must determine how to apportion to individual licenses any assignment phase payments and potentially, any capped bidding credit discounts, since in both cases, a single amount may apply to multiple licenses.³²⁸ In order to do so, the Auction System will: (1) calculate, for all licenses won by a bidder with a bidding credit, the total amount of any bidding credit discount for the bidder, capping that amount as needed;³²⁹ (2) apportion the

³²² *Id.* Any single license application may cover up to all of the licenses won by a forward auction bidder and the associated winning bids may be in any amount, i.e., there is no fixed correlation between the number of license applications and the number of licenses granted or the amount of related payments. *Id.* at 6786, para. 534 n.1520.

³²³ *Id.* at 6786, para. 534.

³²⁴ Payments that forward auction bidders make to honor winning bids must be distributed to fund: (1) payments to broadcasters relinquishing spectrum usage rights; (2) specified FCC administrative costs; (3) relocation costs to be funded through the TV Broadcaster Relocation Fund; and (4) the PSTF for specified purposes. *See* 47 U.S.C. §§ 309(j)(8)(G)(iii)(II), 1452(c)(2), 1457.

³²⁵ *Auction 1000 Comment PN*, 29 FCC Rcd at 15795, para. 135. For example, the Commission determined in the *Incentive Auction R&O* that winning bidders going off-air in the reverse auction would be required to vacate their pre-auction channels within three months of receiving payment of their share of auction proceeds. *Incentive Auction R&O*, 29 FCC Rcd at 6802, para. 575. The ability of stations that are assigned to new channels to move in the repacking process may be dependent on other stations' moves. *See id.* at 6798–99, para. 566 & n.1597. Hence there may be situations in which prioritizing payment to a particular winning bidder may expedite the transition process for other broadcasters.

³²⁶ The total amount that the bidder will owe will reflect any bidding credits, including any caps on such credits, and a one percent discount on the final clock price for every percentage of impairment on an impaired license.

³²⁷ The *Channel Reassignment PN* will include the type information that is traditionally contained in an auction closing public notice.

³²⁸ For example, a single assignment phase payment will apply to multiple licenses if a bidder won multiple licenses in a PEA or if PEAs were grouped for bidding in the assignment phase. A single capped bidding credit will apply if a bidder's bidding credit percentage as applied to all its winnings in small markets or in all markets overall, results in a discount larger than the applicable cap.

³²⁹ For a winning bidder claiming a small business bidding credit, this requires a determination in (1) of which cap(s) apply. As discussed in § III.C.8.c, a small business winning bidder is subject to a \$150 million aggregate cap, of which at most \$10 million may apply to any and all licenses won in PEAs 118-416, with the exception of PEA 412

(continued....)

total discount amount to the group of licenses won by the bidder in each PEA or assignment phase PEA group; (3) apportion the resulting discount and the assignment phase payment among the individual licenses won in the PEA/PEA group; and finally, (4) calculate the license price net of any bidding credit discount as the sum of the impairment adjusted clock phase price for that license plus the amount apportioned to the license in (3).³³⁰

173. Consistent with past practices, the verification of eligibility and final calculation of any designated entity benefits for any license won in Auction 1002 will be conducted during the post-auction application process.

2. Down Payments

174. Within ten business days after release of the *Channel Reassignment PN*, each winning bidder must submit sufficient funds (in addition to its upfront payment) to bring its total amount of money on deposit with the Commission for Auction 1002 to twenty percent of the amount of its total final payments net of any applicable small business or rural service provider bidding credits.³³¹

3. Final Payments

175. Each winning bidder will be required to submit the balance of the net amount of its total final payments within ten business days after the applicable deadline for submitting down payments.³³²

4. Post-Auction Application (FCC Form 601)

176. The Commission's rules provide that, within ten business days after release of the *Channel Reassignment PN*, winning bidders must electronically submit a properly completed post-auction application (FCC Form 601) for the license(s) they won through Auction 1002.³³³

177. A winning bidder claiming eligibility for a small business bidding credit or a rural service provider bidding credit must demonstrate its eligibility in its FCC Form 601 post-auction application for the bidding credit sought.³³⁴ Further instructions on these and other filing requirements will be provided to winning bidders in the *Channel Reassignment PN*.

178. Winning bidders organized as bidding consortia must comply with the FCC Form 601 post-auction application procedures established in the *CSEA/Part 1 Report and Order*.³³⁵ Specifically, each member (or group of members) of a winning consortium seeking separate licenses will be required to file a separate post-auction application for its respective license(s). If the license is to be partitioned or disaggregated, the member (or group) filing the post-auction application must provide the relevant partitioning or disaggregation agreement in its post-auction application. In addition, if two or more

(Continued from previous page) _____

(Puerto Rico), which exceeds the 500,000 pop threshold. Thus, if both caps would be exceeded, \$10 million is apportioned across licenses won in small markets and the remainder \$140 million across licenses won in other markets.

³³⁰ To calculate the gross individual license price, the Auction System will ignore any apportioned bidding credit discount. For more detailed information about how final license prices are determined, please see Attachment 1, Appendix H (Forward Auction Assignment Phase and Post-Auction License Prices), attached to this Public Notice

³³¹ 47 C.F.R. § 1.2107(b).

³³² 47 C.F.R. § 1.2109(a).

³³³ 47 C.F.R. § 1.2107(c).

³³⁴ 47 C.F.R. § 1.2112(b).

³³⁵ *CSEA/Part 1 Report and Order*, 21 FCC Rcd at 911-12, paras. 51-52. Applicants applying as consortia should review the *CSEA/Part 1 Report and Order* in detail, and monitor and carefully review any relevant Commission proceedings (see e.g., *Part 1 R&O*) to understand how the members of the consortia will apply for a license in the event they are winning bidders.

consortium members wish to be licensed together, they must first form a legal business entity, and the post-auction application must demonstrate that any such entity must meet the applicable designated entity criteria.³³⁶

5. Ownership Disclosure Information Report (FCC Form 602)

179. Within ten business days after release of the *Channel Reassignment PN*, each winning bidder must also comply with the ownership reporting requirements in sections 1.913, 1.919, and 1.2112 of the Commission's rules by submitting an ownership disclosure information report for wireless telecommunications services (FCC Form 602) with its FCC Form 601 post-auction application.³³⁷

180. If a winning bidder already has a complete and accurate FCC Form 602 on file in Universal Licensing System (ULS), it is not necessary to file a new report, but the winning bidder must certify in its FCC Form 601 application that the information on file with the Commission is complete and accurate. If the winning bidder does not have an FCC Form 602 on file, or if it is not complete and accurate, it must submit one.

181. When a winning bidder submits an FCC Form 175, ULS automatically creates an ownership record. This record is not an FCC Form 602, but may be used to pre-fill the FCC Form 602 with the ownership information submitted on the winning bidder's FCC Form 175 application. A winning bidder must review the pre-filled information and confirm that it is complete and accurate as of the filing date of the FCC Form 601 post-auction application before certifying and submitting the FCC Form 602. Further instructions will be provided to winning bidders in the *Channel Reassignment PN*.

6. Tribal Lands Bidding Credit

182. A winning bidder that intends to use its license(s) to deploy facilities and provide services to federally recognized tribal lands that are unserved by any telecommunications carrier or that have a wireline penetration rate equal to or below 85 percent is eligible to receive a tribal lands bidding credit as set forth in sections 1.2107 and 1.2110(f) of the Commission's rules.³³⁸ A tribal lands bidding credit is in addition to, and separate from, any other bidding credit for which a winning bidder may qualify.

183. Unlike other bidding credits that are requested prior to the auction, a winning bidder applies for the tribal lands bidding credit after the auction when it files its FCC Form 601 post-auction application. When initially filing the post-auction application, the winning bidder will be required to advise the Commission whether it intends to seek a tribal lands bidding credit, for each license won in the auction, by checking the designated box(es). After stating its intent to seek a tribal lands bidding credit, the winning bidder will have 180 days from the close of the post-auction application filing window to amend its application to select the specific tribal lands to be served and provide the required tribal government certifications. Licensees receiving a tribal lands bidding credit are subject to performance criteria as set forth in section 1.2110(f)(3)(vii).³³⁹ For additional information on the tribal lands bidding credit, including how the amount of the credit is calculated, applicants should review the Commission's rulemaking proceeding regarding tribal lands bidding credits and related public notices.³⁴⁰

³³⁶ *Id.*

³³⁷ 47 C.F.R. §§ 1.913, 1.919, 1.2107(f) and 1.2112.

³³⁸ 47 C.F.R. §§ 1.2107 and 1.2110(f).

³³⁹ See 47 C.F.R. §§ 1.2110(f)(3)(ii)—(vii).

³⁴⁰ See generally, *Extending Wireless Telecommunications Services to Tribal Lands*, WT Docket No. 99-266, Report and Order and Further Notice of Proposed Rule Making, FCC 00-209, 15 FCC Rcd 11794 (2000); Second Report and Order and Second Further Notice of Proposed Rulemaking, FCC 03-51, 18 FCC Rcd 4775, 4778-79 ¶ 10 (2003); Third Report and Order, FCC 04-202, 19 FCC Rcd 17652 (2004). See also *Wireless Telecommunications Bureau Announces Enhancements to the Universal Licensing System to Help Winning Bidders of FCC Auctions File for Tribal Land Bidding Credits*, Public Notice, DA 01-613, 16 FCC Rcd 5355 (2001); *Wireless*

(continued....)

7. Default and Disqualification

184. Any winning bidder that defaults or is disqualified after the close of the auction (i.e., fails to remit the required down payment within the prescribed period of time, fails to submit a timely FCC Form 601 post-auction application, fails to make full payment, or is otherwise disqualified) will be subject to the payments described in section 1.2104(g)(2).³⁴¹ The default payment consists of a deficiency payment, equal to the difference between the amount of the Auction 1002 bidder's winning bid³⁴² and the amount of the winning bid the next time a license covering the same spectrum is won in an auction, plus an additional payment equal to a percentage of the defaulter's bid or of the subsequent winning bid, whichever is less.

185. The percentage of the bid that a defaulting bidder must pay in addition to the deficiency will depend on the auction format ultimately chosen for a particular auction. The Commission's rules specify that in an auction without combinatorial bidding, such as Auction 1002, the percentage shall be between three and 20 percent.³⁴³ In the *Auction 1000 Comment PN*, the Commission proposed an additional default payment of 20 percent of the applicable bid for the forward auction, concluding that the maximum amount is in the public interest given the importance of deterring defaults in order to minimize the possibility that the actual proceeds generated by the auction will not differ significantly from the amounts used to determine that the final stage rule is met.³⁴⁴ The Commission received no comment on this proposal.³⁴⁵ Given the policy and public interest considerations underlying this proposal, and in the absence of any opposition, the Bureau adopts an additional default payment of 20 percent for Auction 1002.³⁴⁶

186. Finally, in the event of a default, the Commission has the discretion to re-auction the license or offer it to the next highest bidder (in descending order) at its final bid amount.³⁴⁷ In addition, if a default or disqualification involves gross misconduct, misrepresentation, or bad faith by an applicant, the Commission may declare the applicant and its principals ineligible to bid in future auctions, and may

(Continued from previous page)

Telecommunications Bureau Releases Additional Information Regarding the Procedures for Obtaining a Tribal Lands Bidding Credit and List of Tribal Lands, Public Notice, DA 00-2836, 15 FCC Rcd 24838 (2000); *Wireless Telecommunications Bureau Announces Availability of Bidding Credits for Providing Wireless Services to Qualifying Tribal Lands: Tribal Lands Bidding Credits to be Available Beginning in Auction No. 36 (800 MHz Specialized Mobile Radio (SMR) Lower 80 Channels) and in Future Auctions*, Public Notice, DA 00-2219, 15 FCC Rcd 18351 (2000). Relevant documents can be viewed on the Commission's website by going to <http://wireless.fcc.gov/auctions/> and clicking on the Tribal Lands Credits link.

³⁴¹ 47 C.F.R. § 1.2104(g)(2).

³⁴² In this context, the "winning bid" refers to the calculated license price discussed in § IV.C.1 (Calculating Individual License Prices) and set forth in § 9 of Appendix H in Attachment 1 (Forward Auction Assignment Phase and Post-Auction License Prices) to this Public Notice.

³⁴³ *Id.*

³⁴⁴ See *Auction 1000 Comment PN*, 29 FCC Rcd at 15815, para. 209. As the Commission noted in the *Incentive Auction R&O*, parties receiving the first disbursements of auction proceeds once amounts become available for distribution—including broadcasters relinquishing spectrum usage rights—will be insulated from the effects of any forward auction bidder defaults. See *Incentive Auction R&O*, 29 FCC Rcd at 6787, para. 536 n.1526.

³⁴⁵ On October 7, 2015, AT&T submitted an *ex parte* supporting an additional default payment of 20 percent for Auction 1002. See AT&T Oct. 7, 2015 *Ex Parte* Letter at 2. We do not address the additional issues raised in AT&T's *ex parte* letter as they are beyond the scope of this Public Notice.

³⁴⁶ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8979-80 para. 3.

³⁴⁷ 47 C.F.R. §§ 1.2109(b) and (c).

take any other action that it deems necessary, including institution of proceedings to revoke any existing authorizations held by the applicant.³⁴⁸

8. Refund of Remaining Upfront Payment Balance

187. After the auction, an applicant that is not a winning bidder or is a winning bidder whose upfront payment exceeded the net amount of its total final payments may be entitled to a refund of some or all of its upfront payment. Information about requesting a refund of a remaining upfront payment balance will be provided in the *Upfront Payment PN*. A bidders should not request a refund of their upfront payments before the Commission releases a public notice declaring the auction closed, identifying the winning bidders, and establishing the deadlines for submitting down payments, FCC Form 601 post-auction applications, and final payments.

V. CONTACTS

188. For further information concerning Auction 1000, including Auction 1001 and 1002, contact the offices listed below:

FCC Auctions Hotline

General Auction Questions
Auction Process and Procedures

(888) 225-5322, option two; or
(717) 338-2868
Hours of service: 8:00 a.m. – 5:30 p.m. ET,
Monday through Friday

Auctions and Spectrum Access Division, Wireless Telecommunications Bureau

For general auction questions:	Linda Sanderson at (717) 338-2868
For Auction 1001 (reverse) auction legal questions:	Erin Griffith or Kathryn Hinton at (202) 418-0660
For Auction 1002 (forward) auction legal questions:	Valerie Barrish or Leslie Barnes at (202) 418-0660

Broadband Division, Wireless Telecommunications Bureau

For 600 MHz Band service rules and licensing questions:	Madelaine Maior at (202) 418-1466 or Jonathan Campbell at (202) 418-0605
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Competition and Infrastructure Policy Division, Wireless Telecommunications Bureau

For mobile spectrum holdings questions:	Karen Sprung at (202) 418-2762
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Video Division, Media Bureau

For broadcaster questions:	Dorann Bunkin at (202) 418-1636
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Office of Engineering and Technology

For legal repacking and inter-service interference questions:	Aspasia Paroutsas at (202) 418-7285
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For technical repacking and inter-service interference questions:	Martin Doczkat at (202) 418-2435
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³⁴⁸ 47 C.F.R. § 1.2109(d).

Technical Support

Electronic Filing
FCC Auction System (Hardware/Software Issues)

(877) 480-3201, option nine; or (202) 414-1250
(202) 414-1255 (TTY)
Hours of service: 8:00 a.m. – 6:00 p.m. ET,
Monday through Friday

Payment Information

Wire Transfers
Refunds

Gail Glasser at (202) 418-0578, or alternatively,
Theresa Meeks at (202) 418-2945, or (202) 418-
2980 (fax)

Auction Bidder Line

Will be furnished only to qualified bidders

Press Information

For press questions:

Charles Meisch at (202) 418-2943

FCC Forms

(800) 418-3676 (outside Washington DC)
(202) 418-3676 (in the Washington DC
area)
<http://www.fcc.gov/formpage.html>

Consumer and Governmental Affairs Bureau

For Accessible Formats

(202) 418-0530 or (202) 418-0432 (TTY)
fcc504@fcc.gov

Office of Communications Business Opportunities

For questions concerning small business inquiries:

(202) 418-0990
<http://www.fcc.gov/ocbo/>

FCC Internet Sites

<http://www.fcc.gov/auctions/1000>
<http://www.fcc.gov/auctions/1001>
<http://www.fcc.gov/auctions/1002>
<http://www.fcc.gov>
<http://wireless.fcc.gov/auctions>
<http://www.fcc.gov/mb>
<http://apps.fcc.gov/ecfs/>

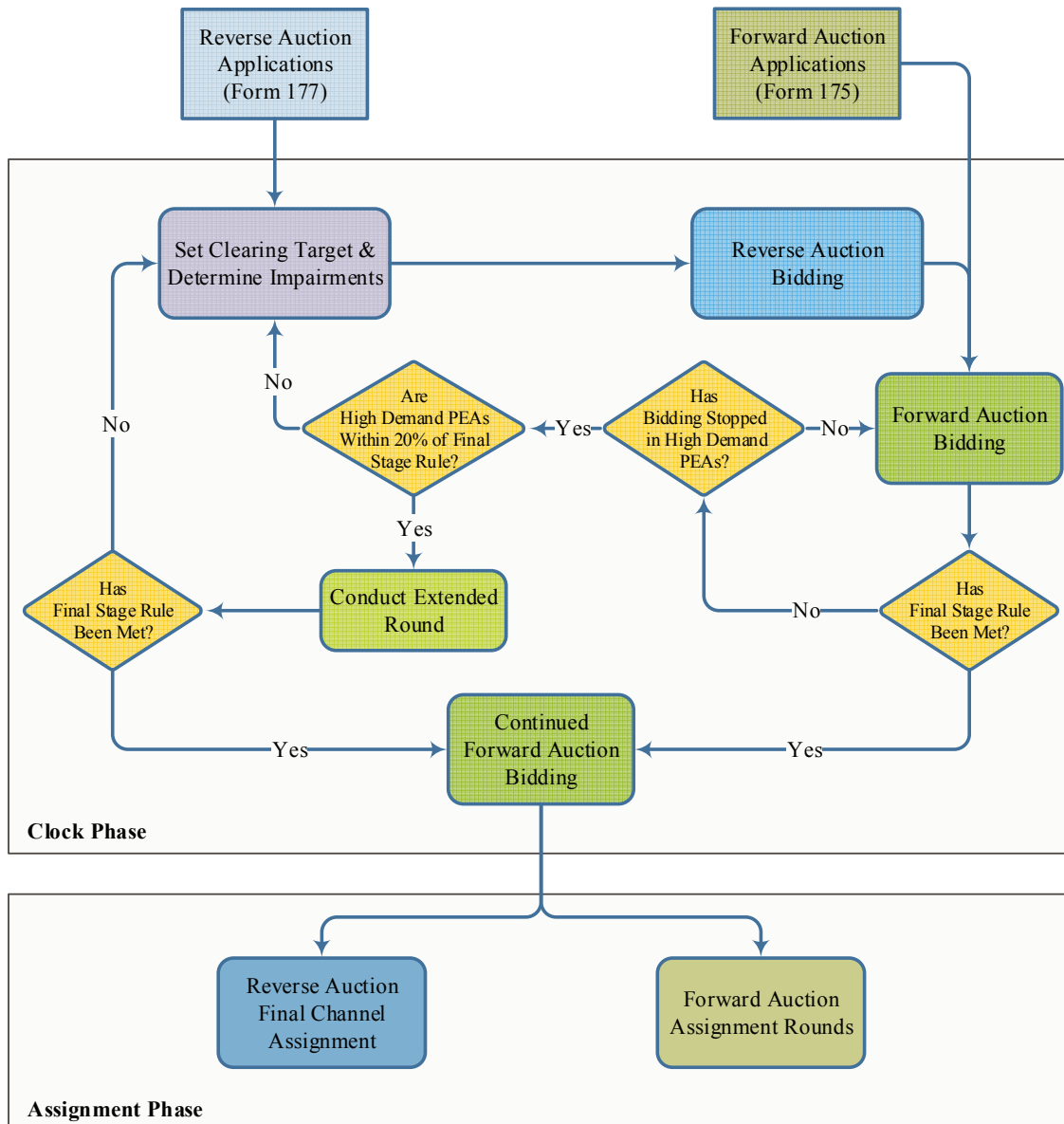
ATTACHMENT 1**Updated Technical Appendices to the *Auction 1000 Comment PN***

This page was intentionally inserted as a cover page for Attachment 1, which consists of the following technical appendices:

- APPENDIX A — Broadcast Incentive Auction Flow
- APPENDIX B — Inter-service Interference (ISIX) Constraints
- APPENDIX C — Clearing Target Optimization
- APPENDIX D — Reverse Auction Pricing and Bid Processing Algorithm
- APPENDIX E — Final Channel Assignment Optimization
- APPENDIX F — Forward Auction Bidding Units, Upfront Payments, and Minimum Opening Bids
- APPENDIX G — Forward Auction Clock Phase
- APPENDIX H — Forward Auction Assignment Phase and Post-Auction License Prices

APPENDIX A

Broadcast Incentive Auction Flow



APPENDIX B

Inter-service Interference (ISIX) Constraints

1 Introduction

This appendix provides a final version of Appendix B of the *Auction 1000 Comment PN* detailing the process of transforming the raw interference data generated by the Inter-Service Interference (“ISIX”) Methodology into constraints that will be used in the clearing target determination procedure.

In the *ISIX R&O*, the Commission adopted the ISIX Methodology for determining the extent to which 600 MHz licenses offered in the forward auction are considered impaired.¹ The ISIX Methodology and the necessary input values specified in this Appendix are important first steps for defining the products to be sold in the auction.² This document describes the next two steps for defining the products to be sold during the auction. First, this document specifies the method by which the 2x2 kilometer ISIX data for all four ISIX cases is reduced to a county level and grouped by uplink and downlink. Second, this document specifies how this consolidated data is then processed to create constraints used to measure the impaired population in a license area for a given clearing target. These constraints are then used in the clearing target determination procedure adopted in the *Auction 1000 Bidding Procedures PN* to measure and limit the amount of population subject to impairment in areas with market variation.³

In the sections that follow, the methodology used to process the raw ISIX data is described. The final result of that methodology, referred to herein as the ISIX data post processing methodology, is two tables, one for *Downlink* and the other for *Uplink*, that provide an impairment percentage for each county (based on the spectrum clearing target and the 600 MHz Band plan) for every facility-channel assignment combination.

2 Reference Tables

To process raw ISIX data, several pieces of reference data are required.

2.1 Spectrum Information

To determine the extent of interference caused and received by a TV station on a given channel, overlap values are required. Overlap refers to the amount of spectral overlap, in megahertz, between the interfering transmitter channel and the interfered-with receiver channel.⁴ As explained further in the *ISIX*

¹ See *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Second Report & Order and Further Notice of Proposed Rulemaking, 29 FCC Rcd 13071, 13083, para. 23 (2014) (*ISIX R&O*).

² See *ISIX R&O*, App. A, 29 FCC Rcd at 13118–37.

³ See *Broadcast Incentive Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, GN Docket No. 12-268, AU Docket No. 14-252, 30 FCC Rcd 8975, 8983–9008, paras. 12–48 (2015) (*Auction 1000 Bidding Procedures PN*).

⁴ Under the 600 MHz Band Plan adopted in the *Incentive Auction R&O*, six megahertz broadcast television channels will be repurposed as five megahertz wireless blocks. See *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6593 (2014). (*Incentive Auctions R&O*). The difference in channel bandwidth (six vs. five megahertz) means that the wireless spectrum blocks will not perfectly align with the existing television channels and, where market variation exists, there will be varying degrees of spectral overlap between the channels.

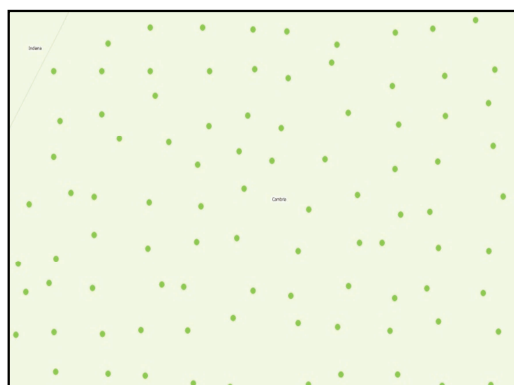
A sample overlap table for the 126 MHz clearing target is shown below. In the band plan associated with this clearing target, stations placed on channels 30 to 42 would cause *downlink* impairments, while stations placed on channels 42 to 49 would cause impairments in the *uplink* (*Note: TV stations will not be placed on channels 50 and 51, and therefore the columns corresponding to these channels are not considered*).⁶ For example, placing a TV Station on channel 43 would potentially create impairments of the A and B uplink blocks, with overlap values of 2 and -3, respectively. Placing a TV station on channel 36 would affect the E and F downlink blocks, with overlap values of -2 and 3, respectively.

[illegible]

2.2 Geographic Information

A country is split into a global 2x2 kilometer (km) grid of cells. Each cell has a centroid point and a unique identifier.

- *pointkey* – Unique ID of each 2x2 km cell
- *area* – Area of 2x2 km cell
- *latitude* – Latitude of population centroid point
- *longitude* – Longitude of population centroid point
- *population* – Population of 2x2 km cell



Centroid points for 2 km x 2 km grid of cells

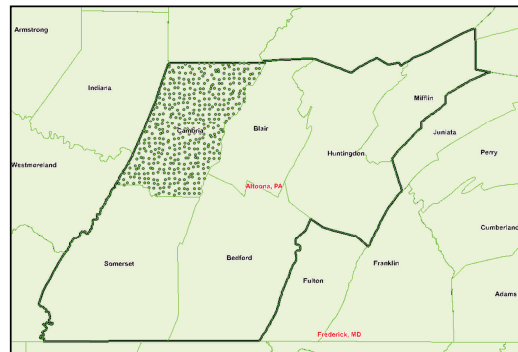
⁶ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8999, para. 35.

Point to County Mapping

The population centroid of each point in the global set of 2x2 km grid of cells lies in a single U.S. county. A lookup table is created by performing a spatial overlay of the global points superset with the 2010 County layer from the U.S. Census Bureau. With this data, the population of each county can also be calculated.

Data elements

- *pointkey* – Unique ID of each 2x2 km cell
- *county FIPS* – 5 character Census identifier of county in which point resides
- *county name* – Name of county in which point resides



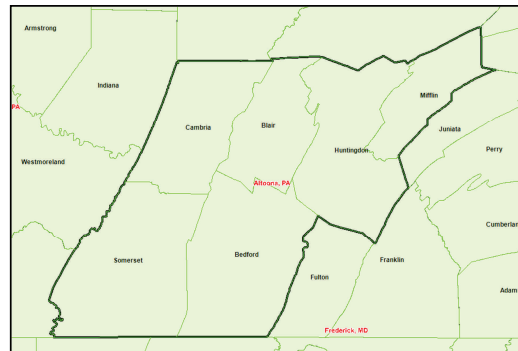
Points in Cambria County, Pennsylvania

County to PEA Mapping

Each U.S. county resides in a Partial Economic Area (PEA). A lookup table is created with this information.

Data elements

- *county FIPS* – 5 character Census identifier for the county
- *PEA ID* – Three digit PEA identifier
- *PEA name* – Name of the PEA

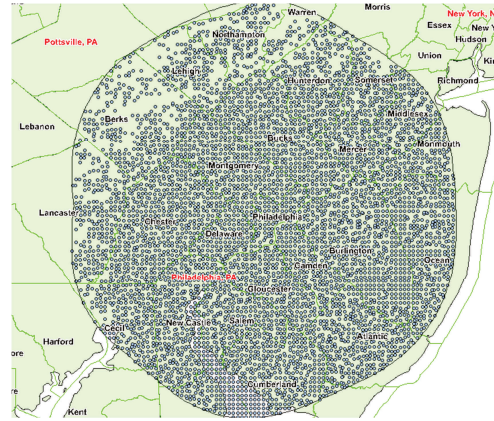


All counties in PEA 121 – Altoona, PA

2.3 TV Station Information

Protected Contour and Terrain-Limited area

The ISIX Methodology, as adopted in the *ISIX R&O*, uses TV channel 38 as a proxy channel and produces information on both the protected contour and the 2x2 km grid cells within the contour that are above the service threshold.⁷ For purposes of this methodology, the protected contour is defined as the noise limited contour of a full-power station or the protected contour of a Class A station.⁸ Terrain-limited area refers to the 2x2 km grid cells where the predicted service is above the service threshold.



**Sample protected TV contour
(Terrain-Limited points)**

3 ISIX Data

Two types of ISIX raw data are produced by the ISIX Methodology:

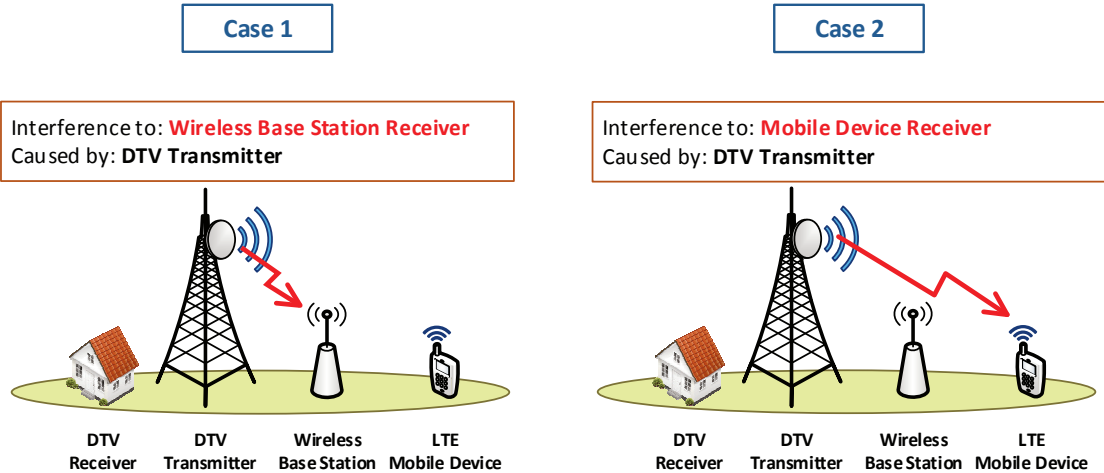
- (1) **Wireless Interference** – Interference to wireless operations caused by TV stations (ISIX Cases 1 & 2)
- (2) **TV Interference** – Interference to TV stations caused by wireless operations (ISIX Cases 3 & 4)⁹

⁷ Channel 38 was selected as a proxy channel because it is approximately in the middle of where a repacked station may potentially be in the 600 MHz Band. See *ISIX R&O*, App. A, 29 FCC Rcd at 13121–22, para. 8 n.10.

⁸ See *Incentive Auction R&O*, 29 FCC Rcd at 6642 (defining a Class A station's “protected contour” as the area within which it is protected from interference under our rules).

⁹ The four cases of interference that the ISIX Methodology considers are described in the Technical Appendix of the *ISIX R&O*. See *ISIX R&O*, App. A, 29 FCC Rcd at 13119–20, para. 5.

3.1 Interference to Wireless (ISIX Cases 1 & 2)



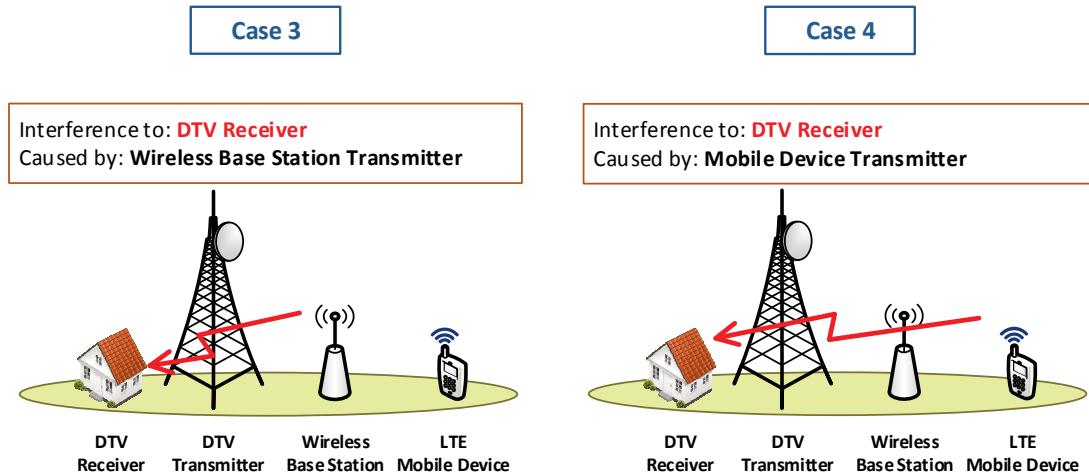
The ISIX Methodology produces the following wireless interference data which is then used as inputs for ISIX data post processing.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
facid	ol	ul_dl	incon	ix	pointKey	margin

- *facid* – Facility ID of the interfering TV station (note: this analysis considers only stations for that have a pre-auction band of UHF).
- *ol* – Spectral overlap used in combination with the “ul_dl” field to define the interference threshold. This analysis considers every overlap case from -5 to +5 MHz for every facility ID.
- *ul_dl* – Flags whether data is for downlink interference (Case 2) or uplink interference (Case 1).
- *incon* – Flags whether a particular interference points falls within the protected TV contour of the facility identified by the “facid” field.
- *ix* – Flags whether the predicted field strength from this facility is above the interference threshold defined by the “ol” and “ul_dl” fields.
- *pointkey* – Unique identifier for each 2x2 km grid cell.
- *margin* – Difference between the interference threshold and the interfering field strength. This analysis does not currently consider this field as it is used to derive the *ix* flag.

For the purposes of the constraint analysis, all points inside the protected contour of the facility (*incon* = 1) and/or all points where interference is predicted (*ix* = 1) are considered.

3.2 Interference to TV (ISIX Cases 3 & 4)



The ISIX Methodology produces the following TV interference raw data which is then used as inputs for ISIX data post processing.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7
facid	ol	ul_dl	incon2	ix	pointKey	cntyid

- *facid* – Facility ID of the TV station interfered with. This analysis considers only UHF stations.
- *ol* – Spectral overlap used in combination with the “ul_dl” field to define the interference threshold. This analysis considers every overlap case from -5 to +5 megahertz for every facility ID.
- *ul_dl* – Flags whether data is for downlink interference (Case 3) or uplink interference (Case 4). (Note: Only downlink interference is included in this file because the uplink interference created by a mobile LTE device is handled separately.)
- *incon2* – For Case 3, this field flags whether the county identified by the “cntyid” field intersects with or comes within 5 km of the protected contour of the facility identified by the “facid” field. If the facility is an international station, the incon2 flag is only set when the county is a border county.¹⁰ For Case 4, this flag indicates if the 2x2 point identified by the “pointKey” field is inside the protected contour of the U.S. facility identified by the “facid” field. If the Case 4 grid point is inside the protected contour of an international facility (on U.S. soil), the incon2 flag is not set.
- *ix* – For Case 3, this field flags whether any hypothetical base station associated with the county identified by the “cntyid” field caused interference inside the facility’s protected contour at the 2x2 km grid cell identified by the “pointKey” field. For Case 4, this field flags all 2x2 km grid points identified by the “pointKey” field that are within 5 km (co-channel) or 0.5 km (adjacent channel) of the TV station’s protected contour, including all points inside the facility’s protected contour.
- *pointkey* – Unique identifier for the 2x2 point inside the TV station’s protected contour.
- *cntyid* – The 5 character county FIPS code (from the U.S. Census Bureau) from which interference could originate.

¹⁰ When an international TV station’s contour covers area inside the U.S., we assume the contour is truncated at the border and only border counties are flagged if they come within 5 km of the international contour. More details about international considerations can be found in Sections 4.4 and 4.5.

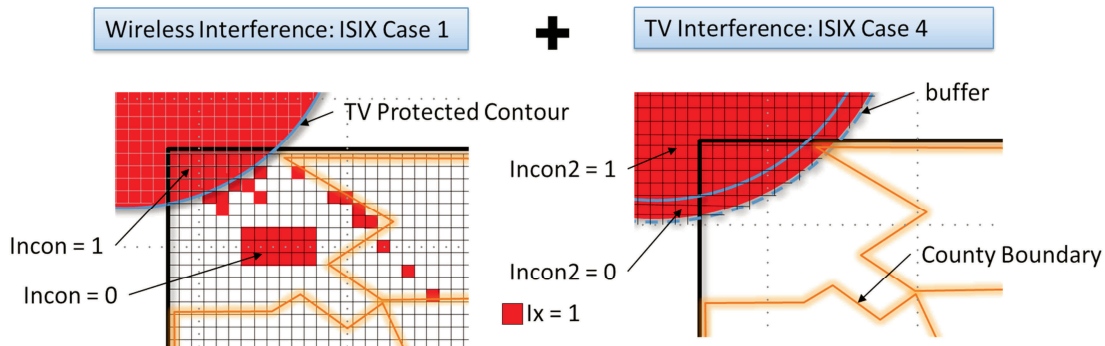
For the purposes of the constraint analysis, all 2x2 km grid points mapped to a county identified in the table above with $ix = 1$ and/or $incon2 = 1$ and $ul_dl = D$ (Case 3) are considered impaired. All 2x2 km grid points identified by the “pointKey” field in the table above with $ix = 1$ and/or $incon2 = 1$ and $ul_dl = U$ (Case 4) are considered impaired.

4 Calculating Percentage of Population Impaired

Downlink and uplink impairments are pre-calculated for every facility and for all applicable overlap values (which are determined by the combination of the clearing target and band plan).

4.1 Uplink Impairment

To calculate Uplink Impairments, Wireless Interference data (ISIX Case 1) and TV Interference Data (ISIX Case 4) are used.

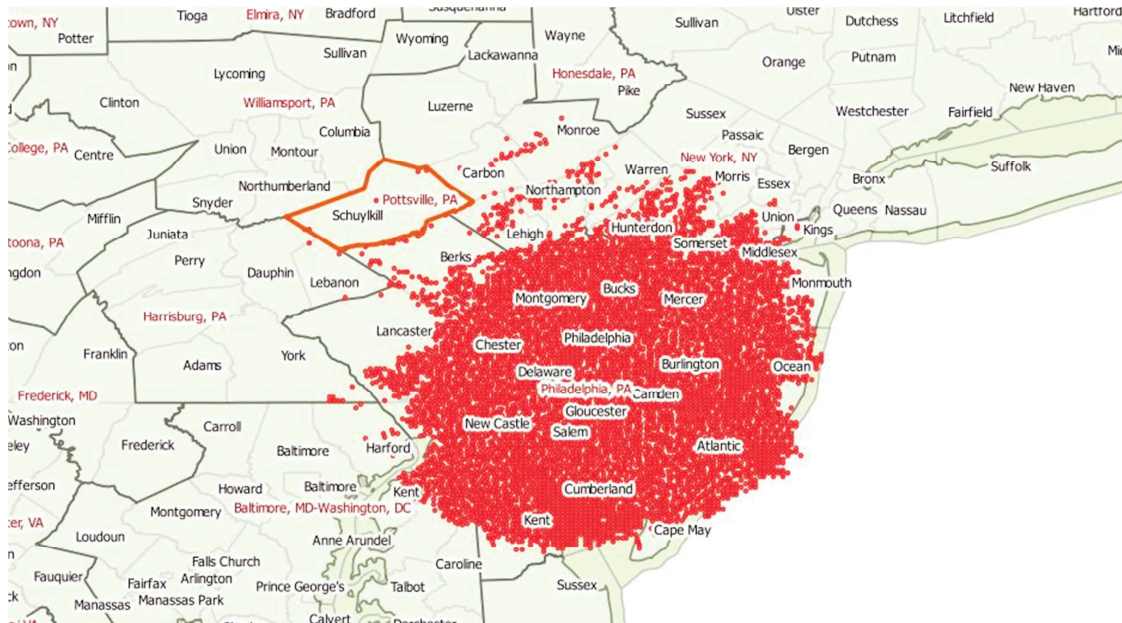


Processing Steps

- 1) Given a facility's channel assignment, use spectrum overlap table to determine the overlap values that must be considered.
- 2) For Case 1, determine the set of grid points that fall within the protected contour ($incon = 1$) and/or are predicted to cause interference ($ix = 1$) to wireless base station receivers. All of these grid points are marked as impaired.
- 3) For Case 4, determine the set of grid points that:
 - a. Are inside a U.S. contour on U.S. soil ($incon2 = 1$) and/or come within 5 km (co-channel) or 0.5 km (adjacent channel) ($ix = 1$);
 - b. Are on U.S. soil and are within 5 km or 0.5 km of a Canadian DTV contour ($incon2 = 0$, $ix = 1$);
 - c. Are on U.S. soil and are within 5 km or 0.5 km of a Mexican DTV contour ($incon2 = 0$, $ix = 1$).
- 4) Find the unique set of impaired points from Steps 2 and 3.
- 5) Sum the population of the impaired points by county using the *Points to County* mapping table.
- 6) Determine the percent of uplink impairment in each county by dividing the sum calculated in Step 5 by the total population of each county.

In this example, the *Uplink* Impairment caused by **facility 25453** (a UHF station in Philadelphia, PA) when it is assigned to **channel 42** is measured. In that case, at a clearing target of 126 MHz, the A-block would be impaired and an overlap value of -4 would need to be considered.¹¹

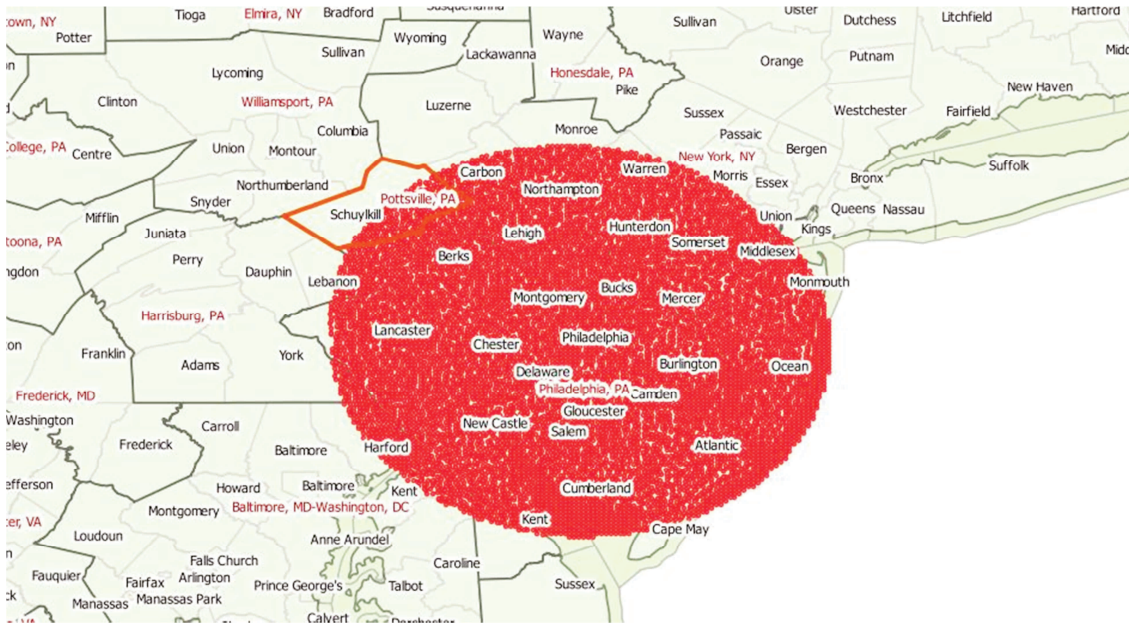
			Spectrum Overlap (by channel)																											
MHz Cleared	Uplink / Downlink	Block	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27	26	25	
126	U	J	5	-1																										
126	U	I	1	4	-2																									
126	U	H	-4	2	3	-3																								
126	U	G		-3	3	2	-4																							
126	U	F			-2	4	1	-5																						
126	U	E				-1	5	0																						
126	U	D					0	5	-1																					
126	U	C					-5	1	4	-2																				
126	U	B						-4	2	3	-3																			
126	U	A							-3	3	2	-4																		
126	D	J										-1	5	0																
126	D	I											0	5	-1															
126	D	H											-5	1	4	-2														
126	D	G												-4	2	3														
126	D	F																3	2	-4										
126	D	E																-2	4	1	-5									
126	D	D																	-1	5	0									
126	D	C																		0	5	-1								
126	D	B																		-5	1	4	-2							
126	D	A																			-4	2	3							



¹¹ It should be noted that placing a station on channel 42 could also impact the Downlink with an overlap value of -1. In this section, however, only the impact on the Uplink is considered.

Placing facility 25453 on channel 42 would cause A-block interference in 41 counties. For example, six grid points of interference (Case 1) exist in Schuylkill County, Pennsylvania. These grid points account for a population of 669.

In addition, there are 242 grid points in Schuylkill County that are either inside or come within 0.5 km¹² of facility 25453's protected contour, which also results in interference (Case 4). These grid points account for a population of 74,001.



Case 4 (Uplink Impairment Data 4): Wireless interference points on Uplink A block (-4 overlap) by facility 25453 on channel 42. Schuylkill County (outlined in ORANGE) has 242 points of interference.

Merging the Case 1 and 4 wireless interference data with the reference tables yields the following data for that county (sample of points shown below).

Uplink Impairment Data

Global Points

Point to County Mapping

	facilityid varchar(10)	channel int	block varchar(1)	ol int	ptkey int	county_fips varchar(15)	county_name varchar(100)	population numeric
1	25453	42	A	-4	130703	42107	Schuylkill	45
2	25453	42	A	-4	130706	42107	Schuylkill	0
3	25453	42	A	-4	130707	42107	Schuylkill	0
4	25453	42	A	-4	130709	42107	Schuylkill	107
5	25453	42	A	-4	130715	42107	Schuylkill	0
6	25453	42	A	-4	130716	42107	Schuylkill	0
7	25453	42	A	-4	130718	42107	Schuylkill	22
8	25453	42	A	-4	130721	42107	Schuylkill	148
9	25453	42	A	-4	160601	42107	Schuylkill	0

¹² A spectral overlap of -4 MHz is considered adjacent-channel interference under the ISIX Methodology and the Case 4 distance based threshold for interference is 0.5 km for adjacent-channel situations.

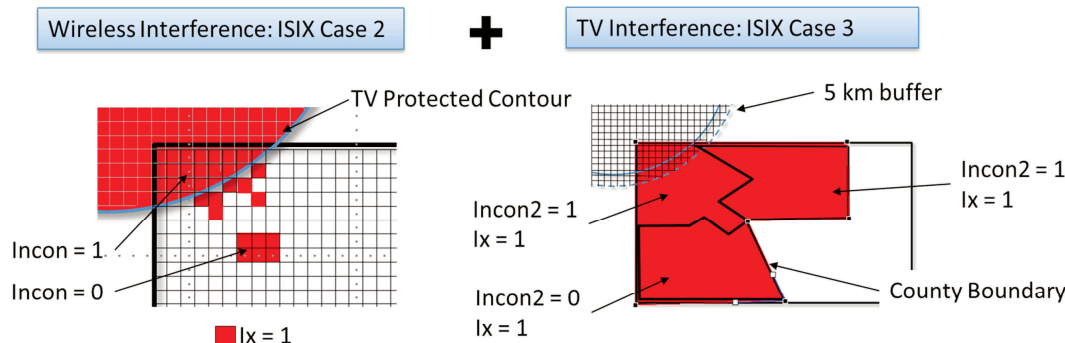
10	25453	42	A	-4	160602	42107	Schuykill	0
11	25453	42	A	-4	160604	42107	Schuykill	0
12	25453	42	A	-4	160605	42107	Schuykill	0

The number of distinct grid points with interference totals 246, which accounts for a population of 74,670. The total population of Schuykill County is 147,465. To calculate the A-block impairment population percentage, the interference population is divided by the total population of the county.

$$UplinkImpairment = \frac{Pop_{Impaired}}{Pop_{County}} = \frac{74,670}{147,465} = 50.64\%$$

4.2 Downlink Impairment

To calculate Downlink Impairments, Wireless Interference data (ISIX Case 2) and TV Interference data (ISIX Case 3) are used.



Processing Steps

- 1) Given a facility's channel assignment, use the spectrum overlap table to determine the overlap values that must be considered.
- 2) For Case 2, find all points that are either flagged as falling within the protected contour (*incon* = 1) and/or are flagged with interference (*ix* = 1) to wireless user equipment (UE). All these points are marked as impaired.
- 3) For Case 3, find all grid points that are within county boundaries that intersect with or come within 5 km of the TV protected contour (*incon2* = 1) and all grid points within county boundaries where a wireless base station transmission could cause interference inside the TV protected contour of U.S., Canadian, or Mexican stations (*ix* = 1). For a given facility id, any county id listed where *incon2* = 1 or *ix* = 1 or both, all the 2x2 points within the county are marked as impaired.
- 4) Find the set of unique impaired points from Steps 2 and 3.
- 5) Sum the population of each impaired point by county using the *Point to County Mapping* reference table.
- 6) Determine the percent of population in each county with downlink impairments by dividing the sum of impaired population by the total county population under Case 2. Then, determine if a county should be considered 100 percent impaired under Case 3. Finally, take the greater of Case 2 and Case 3.

Example: Downlink Impairment from Facility 24543 on Channel 32

In this example, the *Downlink* Impairment caused by facility **25453** (a UHF station in Philadelphia, PA) when it is assigned to **channel 32** is measured. In that case, at a clearing target of 126 MHz, the A-block, B-block, and C-block would have the possibility of being impaired. Overlap values of 2, 4, and -1 would

need to be considered, respectively. An illustrative example for the calculation of impairments on block A-block in Hartford County, Maryland (population 245,073) is shown below.

			Spectrum Overlap (by channel)																											
MHz Cleared	Uplink / Downlink	Block	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30						
126	U	J	5	-1																										
126	U	I	1	4	-2																									
126	U	H	-4	2	3	-3																								
126	U	G		-3	3	2	-4																							
126	U	F			-2	4	1	-5																						
126	U	E				-1	5	0																						
126	U	D					0	5	-1																					
126	U	C					-5	1	4	-2																				
126	U	B						-4	2	3	-3																			
126	U	A							-3	3	2	-4																		
126	D	J										-1	5	0																
126	D	I											0	5	-1															
126	D	H											-5	1	4	-2														
126	D	G												-4	2	3														
126	D	F																	3	2	-4									
126	D	E																	-2	4	1	-5								
126	D	D																		-1	5	0								
126	D	C																			0	5	-1							
126	D	B																			-5	1	-4	-2						
126	D	A																				-4	2	3	-3					

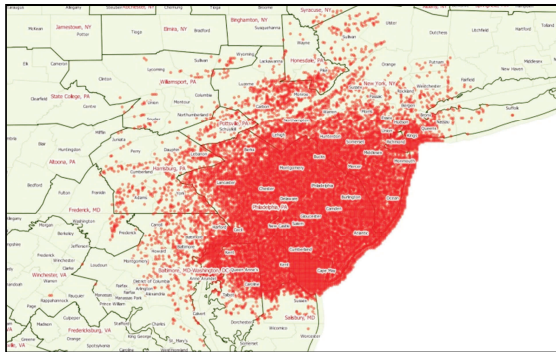


Figure A

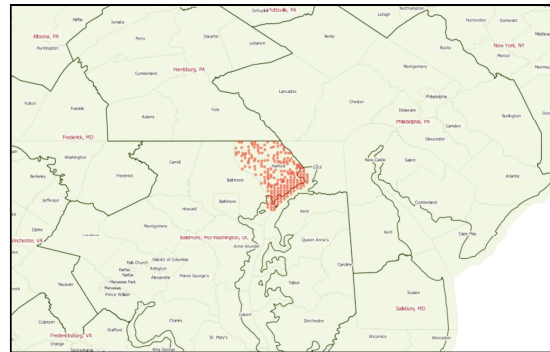
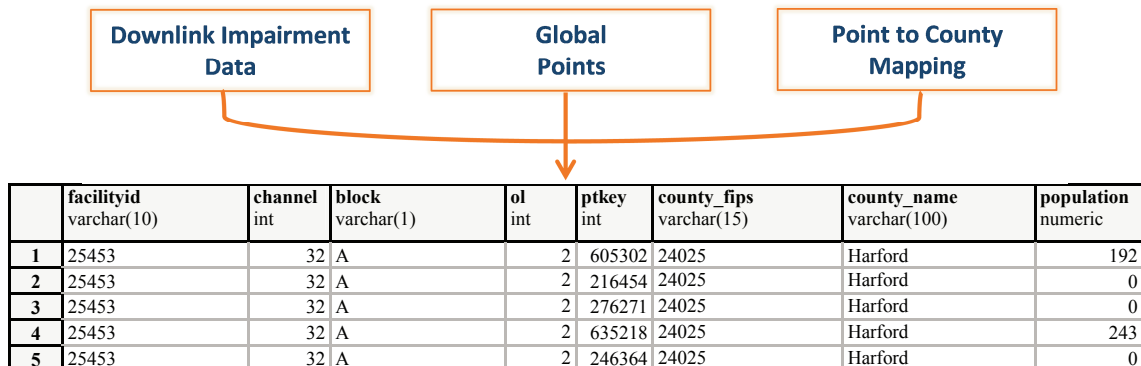


Figure B

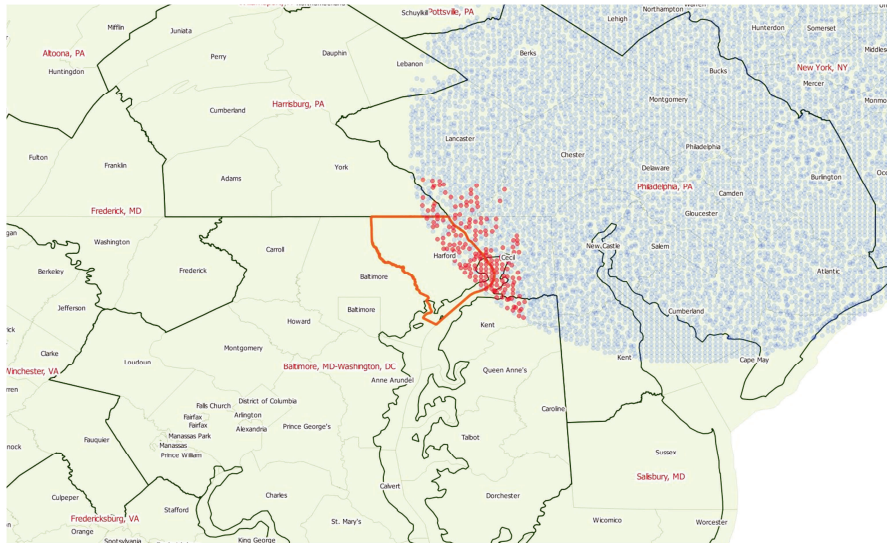
Placing facility 25453 on channel 32 would cause A-block impairments to wireless UEs (ISIX Case 2) in 118 counties (see Figure A above). The relevant data from the Downlink Impairment data is shown below.



	facilityid varchar(10)	channel int	block varchar(1)	ol int	ptkey int	county_fips varchar(15)	county_name varchar(100)	population numeric
6	25453	32	A		2 575413	24025	Harford	214
7	25453	32	A		2 276259	24025	Harford	0
8	25453	32	A		2 336085	24025	Harford	0
9	25453	32	A		2 455734	24025	Harford	3864
10	25453	32	A		2 395899	24025	Harford	0
11	25453	32	A		2 605302	24025	Harford	192
12	25453	32	A		2 216454	24025	Harford	0
...					...			
454	25453	32	B		4 575386	24025	Harford	266
455	25453	32	B		4 605296	24025	Harford	63
456	25453	32	B		4 784756	24025	Harford	175
457	25453	32	C		-1 575386	24025	Harford	266

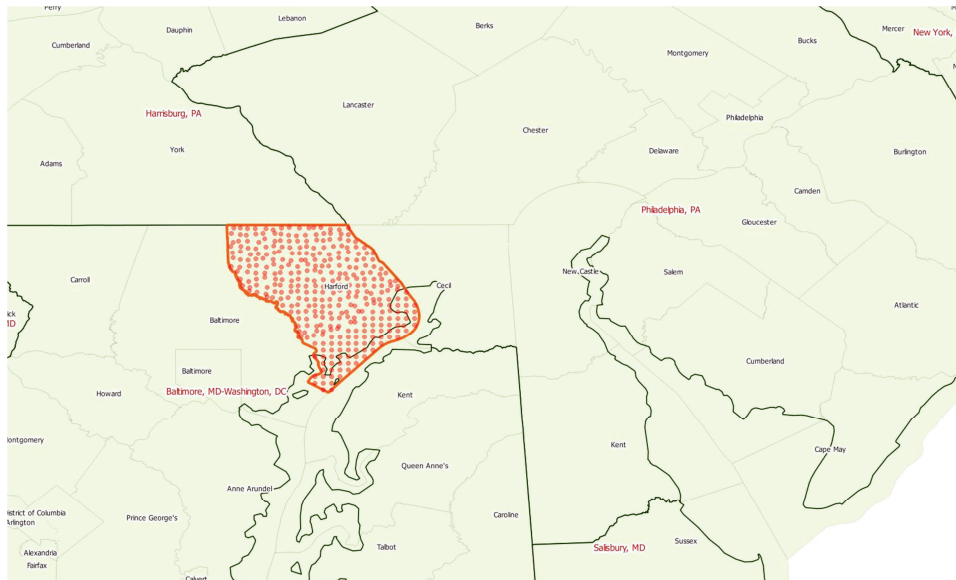
Placing facility 25453 on channel 32 would cause 457 points of interference, which accounts for a population of 160,530 (65.5 percent of the total county population).

In addition to considering data from the *Wireless Interference* table (Case 2), data from the *TV Interference* table (Case 3) must also be considered. The ISIX raw data shows that wireless base stations in Harford County causes interference to 186 grid points inside the TV protected contour of facility 25453. As noted above, as long as even one point within the protected contour of a station is interfered with by a wireless base station in Harford County, regardless of the population of that point, then Harford County would be considered totally impaired.



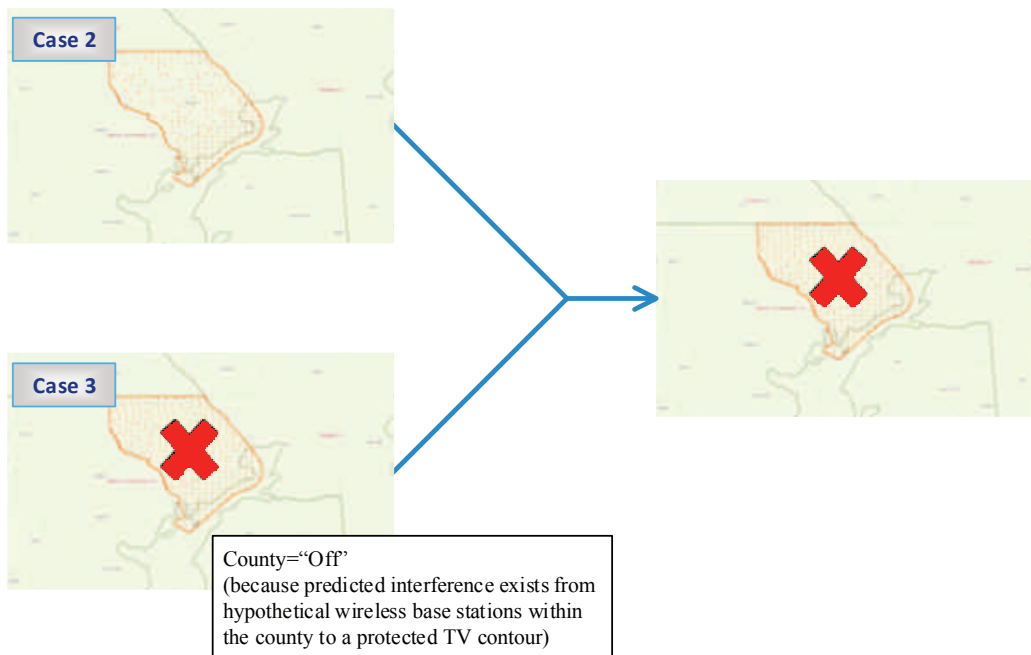
Case 2 (Downlink Impairment Data): Creating a 10 km grid of hypothetical Wireless Base Stations in Harford county (outlined in **ORANGE**) would cause interference to grid points inside the protected TV contour of facility 25453 (illustrated by the **BLUE**). The distinct points of interference are shown in **RED**.

Because there are points of predicted interference within the protected TV contour of facility 25453 originating from at least one hypothetical base station in Harford County, any base station within Harford County is considered to potentially cause interference. To account for this, all points in the county are marked as impaired.



Case 3 (Downlink Impairment Data): All of the grid points (population) in Harford County's A-block would be considered impaired if facility 25453 was placed on channel 32.

To determine the final downlink interference, data from Case 2 and Case 3 must be merged. However, because Case 3 is essentially an “on/off” county-level switch, merging distinct points is very straightforward.



$$\text{DownlinkImpairment} = \frac{\text{Pop}_{\text{Impaired}}}{\text{Pop}_{\text{County}}} = \frac{245,073}{245,073} = 100\% \text{ (due to Case 3)}$$

4.3 Summary

The final result of the ISIX data post processing is two county percentage impairment tables, one for *Downlink* and the other for *Uplink*, that provides the percent of population impaired for each county (based on the clearing target and band plan) for every facility-channel assignment versus wireless channel combination.

As illustrated in the examples, placing facility 25453 on channels 42 or 32 would cause wireless impairments.

Schuylkill County, Pennsylvania (FIPS=42107) – A-Block (Uplink)

Impairment caused by placing facility 25453 on channel 42 = 50.64%

Harford County, Pennsylvania (FIPS=24025) – A-Block (Downlink)

Impairment caused by placing facility 25453 on channel 32 = 100%

4.4 International Considerations: Impairments into the U.S.

In addition to inter-service interference caused by domestic TV and wireless operations, international operations in Canada and Mexico must also be considered when calculating impairments to US wireless license areas for purposes of the auction. The process for determining impairments coming from international operations is consistent with the ISIX methodology adopted by the Commission in the *Auction 1000 Bidding Procedures PN* with the exception of a few changes required by the recently signed agreements with Canada and Mexico.¹³

These considerations are as follows:

Uplink

- Case 1: TV Operations in Canada and Mexico may cause interference to U.S. wireless base stations operating near the border region.¹⁴
- Case 4: Mobile Device transmissions in the U.S. may interfere with TV Operations in Canada and Mexico.¹⁵

Downlink

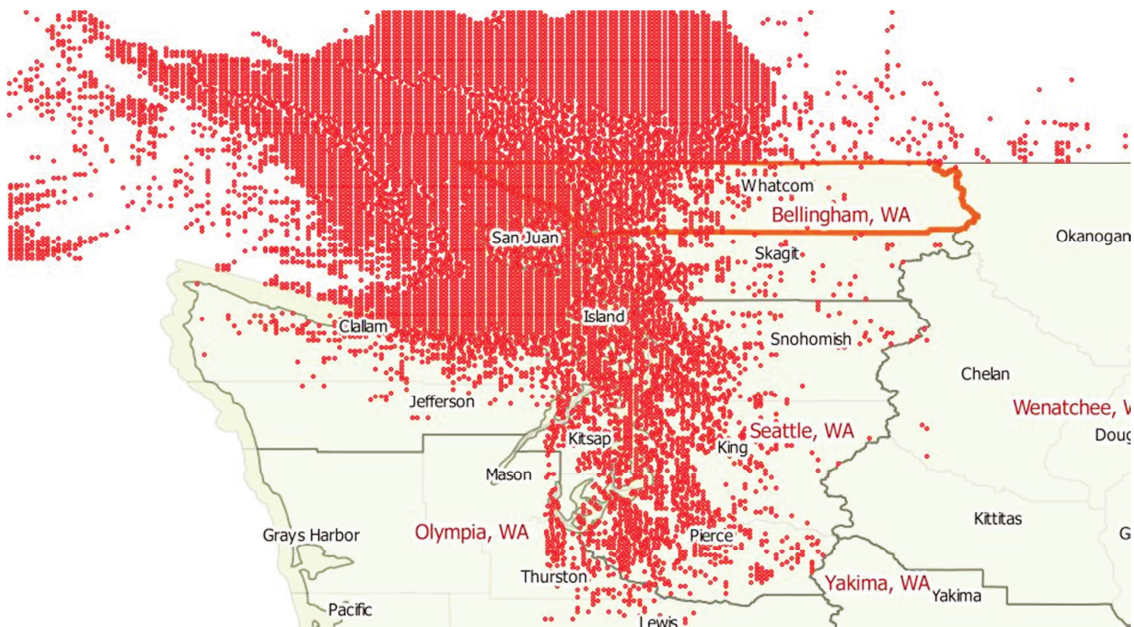
- Case 2: TV Operations in Canada and Mexico may cause interference to wireless downlink U.S. wireless mobile devices operating in near the border region.¹⁶

¹³ See *Statement of Intent Between the Federal Communications Commission of the United States of America and the Department of Industry Canada Related to the Reconfiguration of Spectrum Use in the UHF Band for Over-the-Air Television Broadcasting and Mobile Broadband Services*, U.S.–Can., Aug. 11, 2015, available at <https://transition.fcc.gov/ib/sand/agree/files/PASIIIC.pdf> (Canadian Coordination); *Exchange of Coordination Letters with IFT Regarding DTV Transition and Reconfiguration of 600 MHz Band Spectrum*, U.S.–Mex., July 15, 2015, available at <http://wireless.fcc.gov/incentiveauctions/learn-program/resources.html> (Mexican Coordination); see also *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8985–86, para. 16 (stating that the clearing target selection optimization procedure is subject to international agreements with Canada and Mexico).

¹⁴ Under the terms of the recently signed *Canadian Coordination*, we do not expect uplink impairments from Canada but for sake of completeness for Case 1 impairments, we mention this here.

¹⁵ Case 4 impairments are calculated strictly to inform bidders of possible impairments to U.S. mobile broadband operations of possible areas of future restrictions based on final international power flux density (pfd) limits still to be negotiated.

¹⁶ Under the terms of the recently signed *Canadian Coordination*, we do not expect downlink impairments from Canada but for sake of completeness for Case 2 impairments, we mention this here.



Case 1 (Uplink Impairment Data): Wireless interference points on Uplink B block (3 overlap) by facility 1000092 on channel 44. Whatcom County (outlined in **ORANGE**) has 695 points of interference.

Placing facility 1000092 on channel 44 would cause B-block Case 1 interference in 16 counties. For example, there are 695 points of interference exist in Whatcom County, Washington (in the “Bellingham, WA” PEA). The interference points account for a population of 195,836.



Case 4 (Uplink Impairment Data): Wireless interference points on Uplink B block (3 overlap) by facility 1000092 on channel 44. Whatcom County (outlined in **ORANGE**) has 600 points of interference.

In addition, 600 points of B-block Case 4 interference would exist as of result of placing Canadian facility 1000092 on channel 44. In Whatcom County, Washington the interference points account for a population of 126,347.

Combining Case 1 and Case 4 results in 724 distinct points of interference which accounts for an interference population of 195,970. The total population of Whatcom County is 201,263. To calculate the B-block impairment population percentage resulting from placing facility 1000092 on channel 44, the interference population is divided by the total population of the county.

$$UplinkImpairment = \frac{Pop_{Impaired}}{Pop_{County}} = \frac{195,970}{201,263} = 97.37\%$$

Example #2: Downlink Impairment in U.S. from Facility 1000092 on Channel 32

In this example, the *Downlink* Impairment caused by Canadian facility 1000092 when it is assigned to **channel 32** is measured. In that case, at a clearing target of 126 MHz, the A-block, B-block, and C-block would have the possibility of being impaired. Overlap values of 2, 4, and -1 would need to be considered, respectively. An illustrative example for the calculation of impairments on block B-block in Whatcom County, Washington (population 201,263) is shown below.

MHz Cleared	Uplink / Downlink	Block	Spectrum Overlap (by channel)																											
			51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30						
126	U	J	5	-1																										
126	U	I	1	4	-2																									
126	U	H	-4	2	3	-3																								
126	U	G		-3	3	2	-4																							
126	U	F			-2	4	1	-5																						
126	U	E				-1	5	0																						
126	U	D					0	5	-1																					
126	U	C					-5	1	4	-2																				
126	U	B						-4	2	3	-3																			
126	U	A							-3	3	2	-4																		
126	D	J										-1	5	0																
126	D	I											0	5	-1															
126	D	H											-5	1	4	-2														
126	D	G												-4	2	3														
126	D	F																3	2	-4										
126	D	E																-2	4	1	-5									
126	D	D																	-1	5	0									
126	D	C																		0	5	-1								
126	D	B																		-5	1	-4	-2							
126	D	A																			-4	2	3	-3						

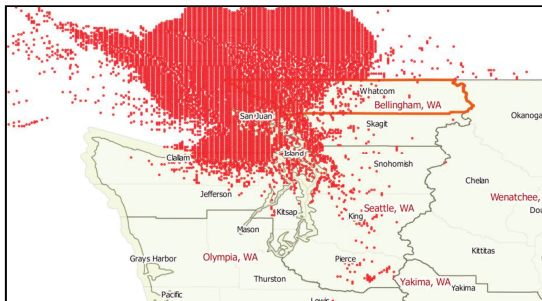


Figure A

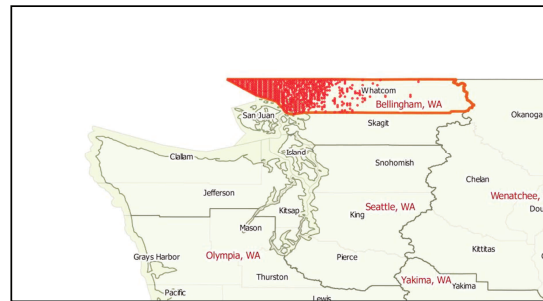
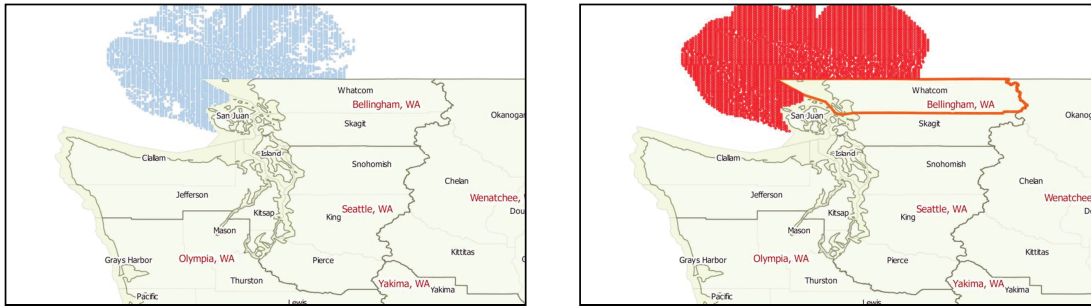


Figure B

Placing facility 1000092 on channel 32 would cause B-block impairments to wireless UEs (ISIX Case 2) in 11 counties (see Figure A above). Given the channel assignment, Whatcom County would experience 584 points of interference, which accounts for a population of 174,938.

In addition to considering data from the *Wireless Interference* table (Case 2), data from the *TV Interference* table (Case 3) is also considered. Hypothetical wireless base stations in Whatcom County are predicted to cause interference to 8,918 grid points inside the TV protected contour of Canadian facility 1000092 (on the Canadian side of the border). As noted above, as long as even one point within the protected contour of a station is interfered with by a hypothetical wireless base station in Whatcom County, then any base station placed within Whatcom County is considered to potentially cause interference. To account for this, all points in the county are marked as impaired.



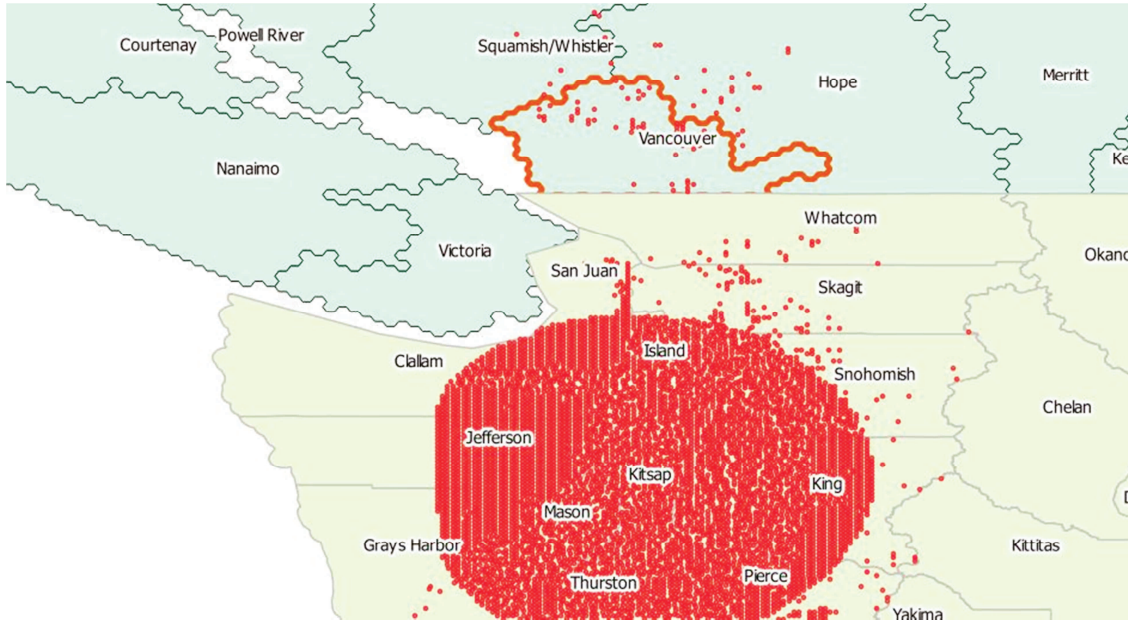
Creating a 10 km grid of hypothetical Wireless Base Stations in Whatcom county (outlined in **ORANGE**) would cause interference to grid points inside the protected TV contour of facility 1000092 (illustrated by the **BLUE**). The distinct points of interference are shown in **RED**.



All of the grid points (population) in Whatcom County's B-block would be considered impaired if facility 1000092 was placed on channel 32.

To determine the final downlink interference, data from Case 2 and Case 3 are merged.

$$\text{DownlinkImpairment} = \frac{\text{Pop}_{\text{Impaired}}}{\text{Pop}_{\text{County}}} = \frac{201,263}{201,263} = \mathbf{100\% \text{ (due to Case 3)}}$$



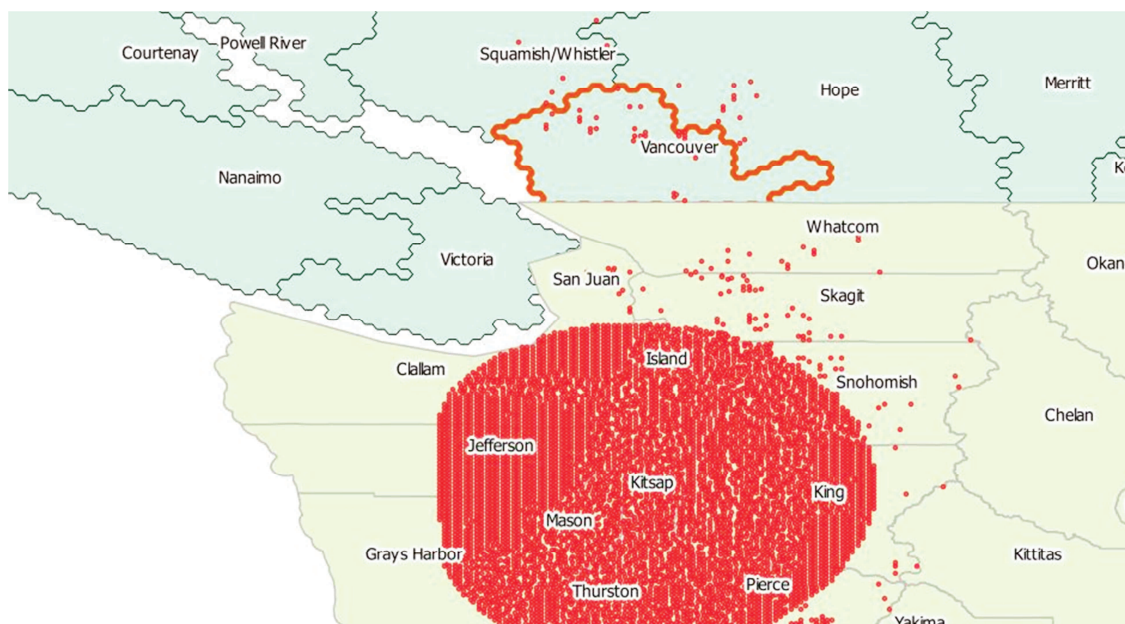
Case 1 (Uplink Impairment Data): Wireless interference points on Uplink H block (-3 overlap) by facility 67950 on channel 48. Vancouver (outlined in **ORANGE) has 64 points of interference.**

Placing facility 67950 on channel 48 would cause H-block Case 1 interference to 64 points and a 13,850 population of in Vancouver.

$$UplinkImpairment = \frac{Pop_{Impaired}}{Pop_{Tier-4}} = \frac{13,850}{2,567,857} = \mathbf{0.5394\%}$$

In this example, the *Downlink* Impairment caused by U.S. **facility 67950** when it is assigned to **channel 41** is measured. In that case, at a clearing target of 126 MHz, the H-block, I-block, and J-block would have the possibility of being impaired. Overlap values of -5, 0, and 5 would need to be considered, respectively. An illustrative example for the calculation of impairments on block H-block in Vancouver (Tier-4 Area), Canada is shown below.

			Spectrum Overlap (by channel)																											
MHz Cleared	Uplink / Downlink	Block	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30						
126	U	J	5	-1																										
126	U	I	1	4	-2																									
126	U	H	-4	2	3	-3																								
126	U	G		-3	3	2	-4																							
126	U	F			-2	4	1	-5																						
126	U	E				-1	5	0																						
126	U	D					0	5	-1																					
126	U	C					-5	1	4	-2																				
126	U	B						-4	2	3	-3																			
126	U	A							-3	3	2	-4																		
126	D	J										-1	5	0																
126	D	I											0	5	-1															
126	D	H											-5	1	4	-2														
126	D	G												-4	2	3														
126	D	F																3	2	-4										
126	D	E																-2	4	1	-5									
126	D	D																	-1	5	0									
126	D	C																		0	5	-1								
126	D	B																	-5	1	4	-2								
126	D	A																			-4	2	3	-4						



Placing facility 67950 on channel 41 would cause H-block Case 1 interference to 41 points and a 4,388 population of in Vancouver.

$$\text{DownlinkImpairment} = \frac{\text{Pop}_{\text{Impaired}}}{\text{Pop}_{\text{Tier-4}}} = \frac{1,705}{2,567,857} = \mathbf{0.1709\%}$$

5 ISIX Constraint Generation

5.1 Introduction

This section describes the process of taking the uplink and downlink county percentage impairment tables and generating constraints that can be used to measure the impaired population in a license area for a given clearing target. This document describes only the ISIX constraints. The full set of constraints that will be used in the clearing target determination procedure will also include the TV to TV pairwise interference constraints.

5.2 Setting a County Impairment Threshold

As discussed in the introduction, the ISIX data is aggregated to a county tile level. Creating the county level tiles for every impairing facility-channel assignment involves applying the 10 percent threshold value established in the *Auction 1000 Bidding Procedures PN* for the percentage of population impaired in a county above which the entire county is considered to be impaired and below which the county is considered to be unimpaired.²⁰ Any county that is more than 10 percent impaired in either the uplink portion or the downlink portion of the 600 MHz Band will be considered “impaired” by that station when it is assigned to that channel. Thus, one must examine both the uplink and the downlink tables and if *either* an uplink or a downlink “pop_pct_wrt_county” is greater than 10 percent, then the county is considered impaired.

Using this rule and the sample county percentage impairment table below, four of the seven counties listed in the example below (Counties 10001, 10003, 24015, and 24029) would be considered to be 100 percent impaired by facility 25453 if assigned to channel 42 because the percent of population impaired in the downlink portion of the county is greater than 10 percent. The other three counties (Counties 10005, 24011, and 24025) would be considered to be unimpaired. Thus, the only information that will be used from the county percentage impairment tables when generating the ISIX constraints is whether an impairment percentage is above or below the threshold. The impairment percentages from the county percentage impairment tables will not be used directly in the constraints.

	region_id varchar(10)	block varchar(2)	ol int	facilityid varchar(5)	channel int	county_fips varchar(5)	county_population numeric	pop_wrt_county numeric	pop_pct_wrt_county numeric	mktid varchar(10)
1	00610001	A	-4	25453	42	10001	163484	134139	82.050	006
2	00610003	A	-4	25453	42	10003	538416	536787	99.697	006
3	14710005	A	-4	25453	42	10005	195362	0	0.000	147
4	00524011	A	-4	25453	42	24011	33907	363	1.071	005
5	00624015	A	-4	25453	42	24015	100360	81557	81.264	006
6	00524025	A	-4	25453	42	24025	245073	5773	2.356	005
7	00524029	A	-4	25453	42	24029	19758	10163	51.437	005

5.3 Uplink-Downlink Rules

In the incentive auction, spectrum blocks will be sold in 5+5 MHz pairs of uplink and downlink spectrum. In creating constraints to measure the level of impairment of a license, the impact to the usability of the license is determined based on both the uplink and the downlink portions of the license. Specifically, a rule is implemented that if either the uplink or the downlink portion of the county is impaired by more than 10 percent then the entire county is considered impaired.

²⁰ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8988, paras. 20–21.

5.4 Generating Constraints

The following constraints are generated to identify counties that are impaired by any combination of stations based on the 10 percent county impairment threshold. These constraints will determine for a given clearing target and channel assignment the percentage of population in each license area that is predicted to be impaired. The constraints are constructed in such a way as to avoid double counting of population where the contour of assigned TV stations assigned to channels in the 600 MHz Band overlap with each other.

Licenses that are greater than 50 percent impaired will not be sold in the allocation phase of the forward auction.²¹ Because licenses in this category will not be offered in the forward auction they are treated as 100 percent impaired. Constraints that enforce this rule are also provided below.

Decision Variables

$x_{s,c}$ is a binary decision variable which has a value of 1 if station s is assigned to channel c and 0 otherwise.

$y_{(a,l)}$ is a binary decision variable which has a value of 1 if county-tile a of license l is impaired and 0 otherwise.

ρ_l represents the total percent of population with predicted impairment in license l .

N_l is a binary variable which has a value of 1 if the license is more than 50 percent impaired and 0 otherwise.

Set Definitions

A_l is the set of county-tiles a covered by license l .

L is the set of impaired licenses; each license is defined by a clearing target, market id, and block.

$SC_{(a,l)}$ are the set of impairing (facility, channel) pairs which impair county-tile a in license l .

Constants

$pct_{(a,l)}$ is the percent of license l 's population in county-tile a .

Constraints

$$\sum_{a \in A_l} pct_{(a,l)} y_{(a,l)} = \rho_l \quad \forall l \in L \quad (1)$$

$$x_{(s,c)} \leq y_{(a,l)} \quad \forall (s,c) \in SC_{(a,l)}, a \in A_l, l \in L \quad (2)$$

$$0 \leq y_{(a,l)} \leq 1 \quad \forall a \in A_l, l \in L \quad (3)$$

$$0 \leq \rho_l \leq 1 \quad \forall l \in L \quad (4)$$

$$\rho_l \leq .5 + (.5)N_l \quad \forall l \in L \quad (5)$$

$$\rho_l \geq N_l \quad \forall l \in L \quad (6)$$

$$N_l \in \{0,1\} \quad \forall l \in L \quad (7)$$

²¹ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9052, para. 151.

Explanation of Constraints**1. Calculation of the total percent of population impaired in each license**

$$\sum_{a \in A_l} pct_{(a,l)} y_{(a,l)} = \rho_l \quad \forall l \in L$$

For every license, this constraint calculates the total percentage of population impaired in the license by summing the percentage of population impaired with respect to the market for all the county-tiles a that have broadband service respectively in license l .

2. Constraints that set the county variables to 1

$$x_{(s,c)} \leq y_{(a,l)} \quad \forall (s,c) \in SC_{(a,l)}, a \in A_l, l \in L$$

For each county in each license, these constraints set a county variable to 1 when a specific (facility, channel) assignment creates impairment of the license in that county. Note that the value of $y_{(a,l)}$ remains 1 even if multiple channel assignments force the county to be impaired. Thus the percentage of license l 's population impaired by a county will only be counted once in the associated constraints of (1).

3. Constraints that restrict the value of the county variables

$$0 \leq y_{(a,l)} \leq 1 \quad \forall a \in A_l, l \in L$$

For each county in each license, these constraints restrict the value of the county variables to be between 0 and 1 inclusive. Note that the constraints are constructed in such a way that, when combined with the objective to minimize the sum of impaired weighted-pops (see Appendix C), these variables will take on the value 0 when the county is not impaired and the license is not more than 50 percent impaired, or 1 when it is. As a result, the model can consider the variables to be continuous but in practice they will be binary.

4. Constraints that restrict the values of the total percent of population with predicted impairment variables

$$0 \leq \rho_l \leq 1 \quad \forall l \in L$$

For each license l , these constraints restrict the value of the total percentage of population with predicted impairment variables to be between 0 and 1 inclusive. A solution value of 0 indicates that there is no predicted impairment in license l , while a value of 1 indicates that this license is predicted to be 100 percent impaired.

5. Constraints that set binary variable N_l to 1

$$\rho_l \leq .5 + (.5)N_l \quad \forall l \in L$$

For each license l , this constraint will force the variable N_l to be 1 whenever the calculated value of ρ_l is greater than or equal to 0.5.

6. Constraints that set the percentage of impairment, ρ_l , to 1

$$\rho_l \geq N_l \quad \forall l \in L$$

For each license l , this constraint will set the impairment percentage of license l to be 100 percent whenever the variable N_l is set to 1. This constraint is coupled with constraint (5) to force the total impairment of the license to be either less than or equal to 50 percent impaired or 100 percent impaired. Thus, whenever the population impairment percentage is greater than 50 percent, the license is considered completely impaired since it will not be available in the forward auction.

7. Constraints that restrict the value of variable N_l

$$N_l \in \{0,1\} \quad \forall l \in L$$

For each license l , the variable N_l is restricted to the value 0 or 1.

Illustration of the ISIX Constraints

This illustration shows how the ISIX constraints measure impairment for a single license. For the following example, consider a license made up of the “A” block in the “Altoona, PA” PEA (PEA # 121) which is made of 6 counties, as shown in Figure 1.

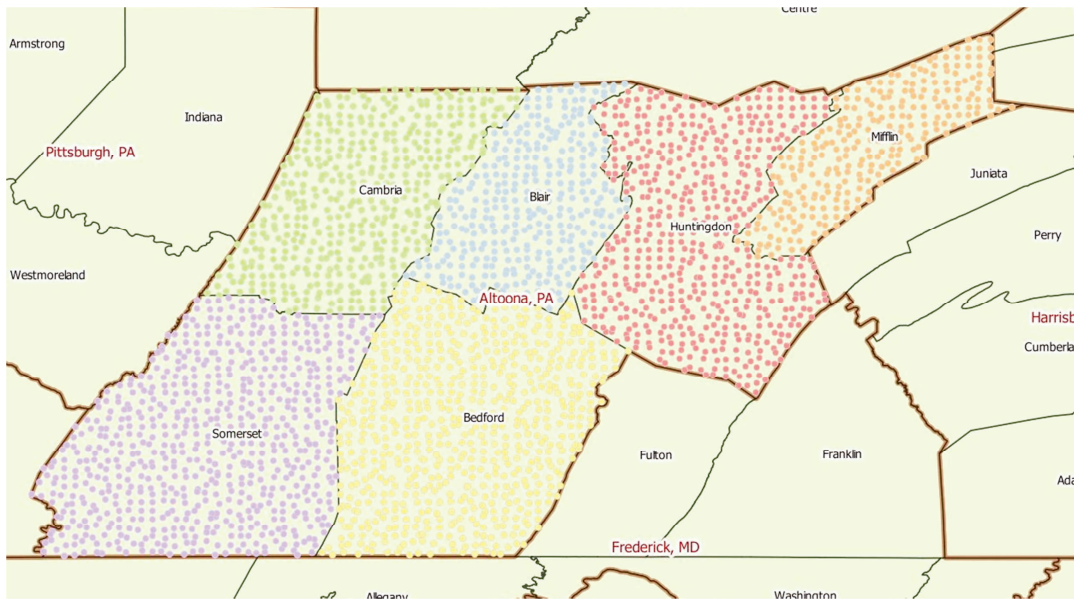


Figure 1. “Altoona, PA” PEA made of 6 counties

For purposes of this example, assume there exists inter-service interference between license A and only three television stations: S1, S2 and S3. Specifically there exists inter-service interference in license A if station S1 is assigned to channels 42 or 47, if station S2 is assigned to channels 41 or 46, and if station S3 is assigned to channels 41 or 46. The amount of interference will change depending on the channel on which the stations broadcast. Generally, interference areas are larger in the uplink portion of the license. Figure 2 shows how the three stations broadcasting on the lower channels cause interference with the downlink portion of the license and Figure 3 shows how the same stations on higher channels cause interference with the uplink portion of the same license.

If the stations broadcast on channels other than these, assume there is no interference with license A. Assume also that there are no co-channel or adjacent channel restrictions among the stations. Based on the calculated county percentage impairment tables, counties whose percentage of population impaired are below the 10 percent threshold will not be considered impaired and ISIX constraints for those counties will not be generated for the associated station-channel pair. Table 1 and Table 2 show the counties where inter-service interference is above and below the threshold for downlink and uplink respectively.

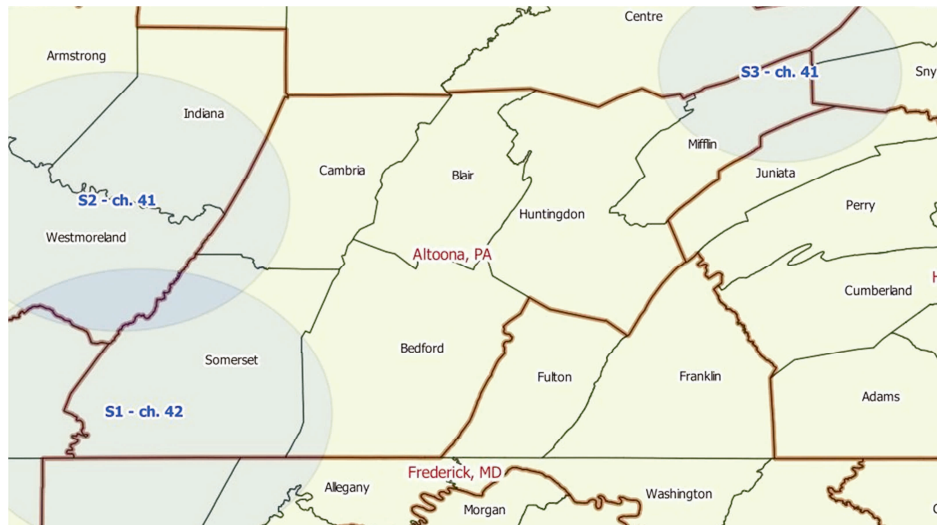


Figure 2. Downlink license interfered by Stations S1, S2, and S3

Station	Channel	Counties with Interference above Threshold	Counties with Interference below Threshold
S1	42	Somerset	Bedford
S2	41	Cambria, Somerset	
S3	41	Mifflin	Huntington

Table 1. Counties with Downlink Interference Above and Below the Threshold

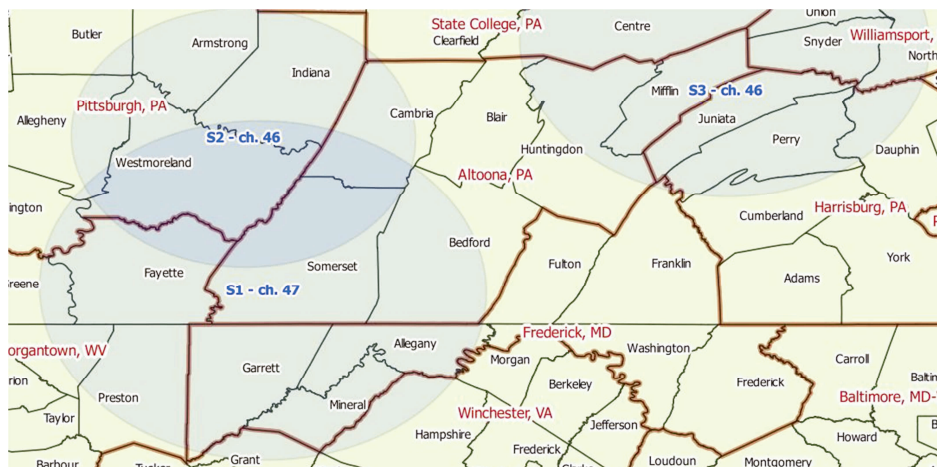


Figure 3. Uplink license interfered by Stations S1, S2, and S3

Station	Channel	Counties with Interference above Threshold	Counties with Interference below Threshold
S1	47	Bedford, Cambria, Somerset	
S2	46	Cambria, Somerset	
S3	46	Huntingdon, Mifflin	Blair

Table 2. Counties with Uplink Interference Above and Below the Threshold

The following shows how the variables and constraints for the station-channel pairs that impair counties above the threshold are created for this license.

Decision Variables

In this small example, station S1 will create interference only if it is assigned either channel 42 or 47. Variables $x_{(S1,42)}$ and $x_{(S1,47)}$ are created for station S1. Similarly variables $x_{(S2,41)}$ and $x_{(S2,46)}$ are created for station S2 and $x_{(S3,41)}$ and $x_{(S3,46)}$ for station S3.

Decision variables are then created for each county in this license with predicted interference above the threshold:

$$y_{(Cambria,A)}; y_{(Mifflin,A)}; y_{(Somerset,A)}; y_{(Bedford,A)}; y_{(Huntingdon,A)}; y_{(Blair,A)}$$

Finally a variable is created that represents the total percent of population impaired in license A of PEA Altoona, PA.

$$\rho_{(Altoona,A)}$$

Constraints

Given these variables, the constraints that calculate the amount of impairment incurred in license A in both the uplink and the downlink portion of the license for the set of possible station-channel assignments are presented below.

The first constraint captures the total percentage of population impaired in the PEA by summing the percentage of population impaired in the county with respect to the PEA. Table 3 shows the population for each county in the example and its associated percentage of the PEA's population.

County Name	Population	Percent of the PEA's Population
Bedford	50237	10.2%
Blair	126884	25.9%
Cambria	144123	29.4%
Huntingdon	45549	9.3%
Mifflin	46792	9.5%
Somerset	77204	15.7%

Table 3. County Population and Percent of PEA Population

With this information a constraint is created that will capture the percentage of population in license A of PEA "Altoona" that has predicted impairment by summing the percentage of population in each county in which the county variables are set to 1.

$$10.2 y_{(Bedford,A)} + 25.9 y_{(Blair,A)} + 29.4 y_{(Cambria,A)} + 9.3 y_{(Huntingdon,A)} + 9.5 y_{(Mifflin,A)} + 15.7 y_{(Somerset,A)} = \rho_{(Altoona,A)}$$

Continuing on with the formulation we create the constraints for the county variables:

Downlink Impairments

$$\begin{aligned} x_{(S1,42)} &\leq y_{(Somerset,A)}; & (\text{Somerset County is impaired if station S1 is assigned channel 42}) \\ x_{(S2,41)} &\leq y_{(Somerset,A)}; & (\text{Somerset County is impaired if station S2 is assigned channel 41}) \\ x_{(S2,41)} &\leq y_{(Cambria,A)}; & (\text{Cambria County is impaired if station S2 is assigned channel 41}) \\ x_{(S3,41)} &\leq y_{(Mifflin,A)}; & (\text{Mifflin County is impaired if station S3 is assigned channel 41}) \end{aligned}$$

Uplink Impairments

- $x_{(S1,47)} \leq y_{(Bedford,A)}$; (Bedford County is impaired if station S1 is assigned channel 47)
 $x_{(S1,47)} \leq y_{(Cambria,A)}$; (Cambria County is impaired if station S1 is assigned channel 47)
 $x_{(S1,47)} \leq y_{(Somerset,A)}$; (Somerset County is impaired if station S1 is assigned channel 47)
 $x_{(S2,46)} \leq y_{(Cambria,A)}$; (Cambria County is impaired if station S2 is assigned channel 46)
 $x_{(S2,46)} \leq y_{(Somerset,A)}$; (Somerset County is impaired if station S2 is assigned channel 46)
 $x_{(S3,46)} \leq y_{(Huntingdon,A)}$; (Huntingdon County is impaired if station S3 is assigned channel 46)
 $x_{(S3,46)} \leq y_{(Mifflin,A)}$; (Mifflin County is impaired if station S3 is assigned channel 46)

In this example, assume that the optimization determines that station S1 should be assigned to channel 42 and station S3 should be assigned to channel 46. S2 is assigned a channel that does not impair license A. The interference between S1 and Somerset County causes the county to be considered 100 percent impaired. The interference between S3 and Huntingdon and Mifflin counties causes these counties to be considered 100 percent impaired. Combining the impairment percentages with the county population percentages, the total impairment of this license for this PEA can be found, as shown in Table 4.

County Name	Percent of the PEA's Population	Percent Impaired	Percent of PEA's Population Impaired
Bedford	10.2%	0%	0%
Blair	25.9%	0%	0%
Cambria	29.4%	0%	0%
Huntingdon	9.3%	100%	9.3%
Mifflin	9.5%	100%	9.5%
Somerset	15.7%	100%	15.7%
TOTAL IMPAIRMENT FOR PEA			34.5%

Table 4. Impairment of license A for this assignment

Using the constraints, the variables would be set as: $x_{(S1,42)} = x_{(S3,46)} = 1$ and $x_{(S2,41)} = x_{(S3,41)} = x_{(S1,46)} = x_{(S2,46)} = 0$. Since this assignment does not create any impairments for Blair, Bedford or Cambria Counties, the associated county variables are set to 0. Therefore, the amount of impairment for this license is set to:

$$10.2 (0) + 25.9(0) + 29.4 (0) + 9.3 (1) + 9.5(1) + 15.7 (1) = 34.5 = \rho_{(Altoona,A)}$$

APPENDIX C

Clearing Target Optimization

1 Introduction

This appendix provides a final version of Appendix C of the *Auction 1000 Comment PN* setting forth the technical details and mathematical models used for the clearing target optimization. The clearing target optimization determines, for a given clearing target, an assignment of television stations. The clearing target optimization is run as part of the clearing target determination procedure both before the start of the reverse auction bidding process and before any subsequent stage of the auction. This final version of Appendix C is updated to implement the Commission's decisions in the *Auction 1000 Bidding Procedures PN* and its recently concluded coordination agreement with Canada.¹

As discussed in Section 2 and as illustrated in Figure 1 below, the initial clearing target optimization involves solving a series of optimization problems in order to identify a provisional assignment of television stations to channels that minimizes impairments to forward auction licenses and accomplishes additional objectives. Each step establishes constraints, or limits on any resulting channel assignment, which apply to subsequent steps. Section 3 explains how the clearing target optimization steps used differ between stages of the auction when the clearing target is reduced, and is illustrated in Figure 2.

The first step in the clearing target optimization is to generate constraints that will ensure that every U.S. and Canadian station eligible for protection in the repacking is assigned to either a relinquishment option or a channel in their pre-auction band.² This step is described in detail in Sections 2.1

The second step determines additional constraints to assign every Canadian station a channel that satisfies the stipulations within the U.S.–Canada coordination agreement.³ The steps taken are described in detail in Sections 2.2.

The third step, which applies at the beginning of the auction but not before any subsequent stage of the auction, determines constraints to accommodate the initial bid commitments of stations that are participating in the reverse auction, according to the priorities proposed in the *Comment PN* and adopted in the *Auction 1000 Bidding Procedures PN*.⁴ This step is described in detail in Section 2.3.

The next four steps of the clearing target optimization apply the objectives for a channel assignment established in the *Auction 1000 Bidding Procedures PN*. The primary objective is to minimize impaired weighted-pops nationwide, based on the measurement procedure the Commission has adopted. The

¹ *Statement of Intent Between the Federal Communications Commission of the United States of America and the Department of Industry Canada Related to the Reconfiguration of Spectrum Use in the UHF Band for Over-the-Air Television Broadcasting and Mobile Broadband Services*, U.S.–Can., Aug. 11, 2015, available at <https://transition.fcc.gov/ib/sand/agree/files/PASIIIC.pdf> (Canadian Coordination); see *Broadcast Incentive Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, GN Docket No. 12-268, AU Docket No. 14-252, 30 FCC Rcd 8975, 8986, para. 16 n.52 (2015) (*Auction 1000 Bidding Procedures PN*).

² See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8984, para. 14 (a feasible channel assignment “satisfies the constraints established in the *Incentive Auction R&O* to make all reasonable efforts to preserve each television station’s coverage area and population served”).

³ Under the coordination agreement, full-power Canadian stations may not be assigned to channels in the 600 MHz Band or the additional guard band, with one exception at the 126 MHz clearing target. See *Canadian Coordination*, App. 4, at 13 tbl.4-1 (“Guardband” parameter).

⁴ *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8985, para. 14 n.47.

secondary objective is to maximize the number of weighted Category 1 licenses available in the forward auction. The secondary objective is constrained by the result of the primary objective (the impaired weighted population, rounded up to the nearest integer). The tertiary objective, which is constrained by the first two, is to minimize impaired weighted-pops over all licenses, including licenses with greater than 50 percent of the population subject to impairment. The final objective, which applies only to clearing targets where the lower guard band is 11 MHz, is to minimize the number of stations placed on the lower channel in the lower guard band without changing the stations assigned to channels in the 600 MHz Band. These four steps are described in detail in Sections 2.4–2.7.

2 Initial Clearing Target Optimization

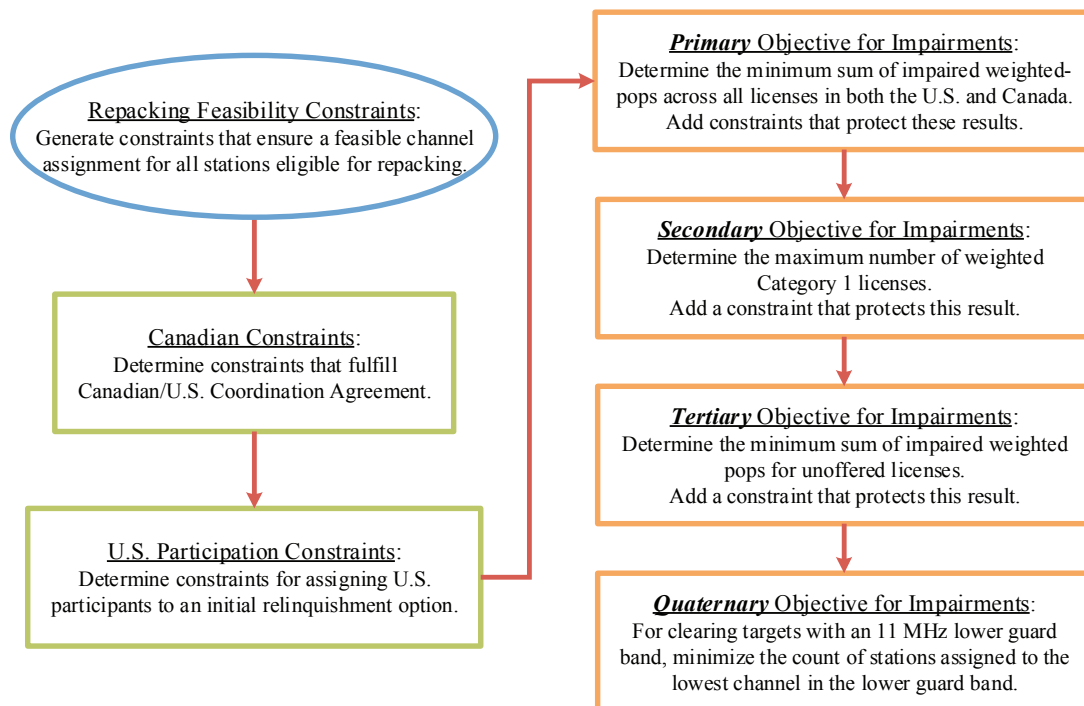


Figure 1: Initial Clearing Target Optimization Flow

2.1.1 Repacking Feasibility Constraints

In the initial clearing target optimization, a feasible assignment is defined as an assignment of TV stations that meets all of the following conditions:

- (1) All stations are assigned, either to a channel or to go off-air.
- (2) A station can only be assigned to one of its allowable channels as defined in the *domain.csv* file.
- (3) A station's assignment must not violate adjacent and co-channel pairwise interference restrictions as defined in the *interference_paired.csv* file.⁵
- (4) All non-participating stations are assigned a channel in their pre-auction band, as are stations that are not needed to bid in the auction.

⁵ *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Report & Order, 29 FCC Rcd 6567, 6619, para. 114 (2014) (*Incentive Auction R&O*).

- (5) All participating stations in the reverse auction are assigned to an option consistent with the bidder's initial commitment(s) (either to go off-air or to a channel in a band it selected), or to a channel in the bidder's pre-auction band.

The linear constraints that enforce conditions (1) through (5) are provided below.

Set Definitions:

S is the set of all stations in both Canada and the U.S.

C_s is the set of allowable channels for station s .

For non-participating stations and stations that are not needed, the set C_s consists exclusively of allowable channels in their pre-auction bands, which for UHF stations includes their allowable channels in the 600 MHz Band. For participating stations, the set C_s consists of allowable channels in their pre-auction band as well as channels in the bands associated with their initial relinquishment commitment(s). For participating stations that made an initial commitment to go off-air,⁶ the set C_s also consists of channel 0 which indicates an off-air assignment.

Variable Definitions:

$x_{s,c}$ is a binary decision variable which has a value of 1 if station s is assigned to channel c and 0 otherwise. Note $c = 0$ indicates the option to go off-air.

Explanation of Constraints:

1. Each station must be assigned.

$$\sum_{c \in C_s} x_{s,c} = 1 \quad \forall s \in S$$

This constraint ensures that every station is assigned to exactly one channel from its set of allowable channel assignments.

2. Station assignments must adhere to the co-channel interference restrictions.

$$x_{s,c} + x_{s',c} \leq 1 \quad \forall \{(s,c), (s',c)\} \in CoPairs$$

For every pairwise restriction that precludes two stations from occupying the same channel, a constraint indicates that at most one of the two stations (s and s') can be assigned to that channel c . The set includes all station pairs that cannot occupy the same channel.

3. Station assignments must adhere to the adjacent channel restrictions.

$$x_{s,c} + x_{s',c'} \leq 1 \quad \forall \{(s,c), (s',c')\} \in AdjPairs$$

For every two station-pairs (s, c) and (s', c') where channels c and c' are adjacent and where if station s is on channel c then station s' cannot be on channel c' , a constraint allows only one of these two assignments. That is, the constraints enforce the adjacent channel requirements.

4. The variables can only take on the values zero or one.

$$x_{(s,c)} \in \{0,1\} \quad \forall s \in S, \forall c \in C_s$$

For each allowable station-channel combination, the value of the variable $x_{s,c}$ is restricted to be either 0 or 1, *i.e.*, the station is either assigned to the channel or it is not.

⁶ This set includes stations that initially committed to a VHF option with a back-up option to go off-air.

As determined by the Commission in the *Auction 1000 Bidding Procedures PN*, no station may be assigned to channels 50 or 51.⁷ The clearing target optimization procedure determines a feasible assignment where all stations can be assigned to some channel other than channels 50 and 51. Once a feasible assignment is found, then channels 50 and 51 are removed from all stations' domains.

2.1.2 Complete Set of Repacking Feasibility Constraints

$$\sum_{c \in C_s} x_{s,c} = 1 \quad \forall s \in S \quad (1)$$

$$x_{s,c} + x_{s',c} \leq 1 \quad \forall \{(s, c), (s', c)\} \in CoPairs \quad (2)$$

$$x_{s,c} + x_{s',c'} \leq 1 \quad \forall \{(s, c), (s', c')\} \in AdjPairs \quad (3)$$

$$x_{(s,c)} \in \{0,1\} \quad \forall s \in S, \forall c \in C_s \quad (4)$$

2.2 Optimizations to Satisfy Canadian/US Coordination Agreements on Joint Repacking

This step in the procedure employs five separate optimizations to determine the minimum number of Canadian stations that must be assigned to either the first TV channel adjacent to the guard band between the TV spectrum and the repurposed mobile broadband spectrum (that is, the highest allowable channel in the TV band)⁸ or to a channel in the 600 MHz Band.

- (C1): Minimize the count of Canadian full power stations that are assigned to the 600 MHz Band and the highest UHF TV channel
- (C2): Minimize the count of Canadian low-power stations assigned to the 600 MHz Band and the highest UHF TV channel while constraining the count of the high-powered Canadian stations to be no more than that obtained in (C1);
- (C3): If the result of (C1) is greater than zero, maximize the count of the full-power Canadian stations on the highest UHF TV Channel subject to the results obtained in (C1) and (C2). This optimization attempts to assign full-power Canadian stations to the highest UHF TV channel rather than in the 600 MHz Band.
- (C4): If the result of (C2) is greater than zero, maximize the count of the low-power Canadian stations on the highest UHF TV Channel subject to the results obtained in (C1), (C2), and (C3). This optimization attempts to assign low-power Canadian stations to the highest UHF TV channel rather than in the 600 MHz Band.
- (C5): If the result of (C3) is greater than zero, minimize the sum of interference-free population for Canadian full-power stations assigned to the highest UHF TV channel, subject to the results obtained in (C1) through (C4).

2.2.1 (C1): Minimize the Count of Canadian Full-power Stations that are Assigned to the 600 MHz Band and the Highest UHF TV Channel

Subset:

HC denotes the highest UHF TV channel for the given clearing target.

$s \in S_{Can,UHF,FP}$ is the set of full-power UHF-based Canadian stations.

⁷ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8999, para. 35.

⁸ Canada requires a larger guard band between TV stations and wireless broadband than does the US. *Canadian Coordination*, App. 4, at 13 tbl.4-1. Thus, Canada considers the highest station in the TV spectrum band (as specified by the US) to be part of their guard band.

$C_s^{600\text{UHC}}$ is the set of 600 MHz channels applicable for the giving clearing target as well as the highest UHF TV channel in the clearing target for station s .

Model Formulation for (C1):

$$\min Z_{C1} = \sum_{s \in S_{\text{Can,UHF,FP}}} \sum_{c \in C_s^{600\text{UHC}}} x_{s,c}$$

Subject to Constraints:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
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2.2.2 (C2): Minimize the Count of Canadian Low-power Stations Assigned to the 600 MHz Band and the Highest UHF TV Subject to the Results Obtained in (C1)

Subset:

$S_{\text{Can,UHF,LP}}$ is the set of low-power UHF-based Canadian stations.

$C_s^{600\text{MHzUHC}}$ is the set of 600 MHz channels applicable for the giving clearing target as well as the highest UHF TV channel in the clearing target for station s .

Model Formulation for (C2):

$$\min Z_{C2} = \sum_{s \in S_{\text{Can,UHF,LP}}} \sum_{c \in C_s^{600\text{UHC}}} x_{s,c}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
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$\sum_{s \in S_{\text{Can,UHF,FP}}} \sum_{c \in C_s^{600\text{UHC}}} x_{s,c} \leq Z_{C1}$	(5)
---	-----

2.2.3 (C3): Maximize the Count of the Full-power Canadian Stations on the Highest UHF TV Channel Subject to the Results Obtained in (C1) and (C2).

This optimization is only performed if the result of (C1) has a value for Z_{C1} that is greater than zero. It attempts to assign full-power stations to the highest UHF TV channel, rather than in the 600 MHz Band, without increasing the number of full-power and low-power Canadian stations in the 600 MHz Band.

Model Formulation for (C3):

$$\max Z_{C3} = \sum_{s \in S_{\text{Can,UHF,FP}}} x_{s,HC}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
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$\sum_{s \in S_{\text{Can,UHF,FP}}} \sum_{c \in C_s^{600\text{UHC}}} x_{s,c} \leq Z_{C1}$	(5)
---	-----

$\sum_{s \in S_{\text{Can,UHF,LP}}} \sum_{c \in C_s^{600\text{UHC}}} x_{s,c} \leq Z_{C2}$	(6)
---	-----

2.2.4 (C4): Maximize the Count of the Low-power Canadian Stations on the Highest UHF TV Channel Subject to the Results Obtained in (C1), (C2), and (C3).

This optimization is only performed if the result of (C2) has a value for Z_{C2} that is greater than zero. It attempts to assign low-power Canadian stations to the highest UHF TV channel, rather than in the 600 MHz Band, without increasing the numbers of full-power and low-power Canadian stations in the 600 MHz Band, or decreasing the number of full-power Canadian stations assigned to the highest UHF TV channel.

Model Formulation for (C4):

$$\max Z_{C4} = \sum_{s \in S_{Can,UHF,LP}} x_{s,HC}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
---	---------

$\sum_{s \in S_{Can,UHF,FP}} \sum_{c \in C_S^{600UHC}} x_{s,c} \leq Z_{C1}$	(5)
---	-----

$\sum_{s \in S_{Can,UHF,LP}} \sum_{c \in C_S^{600UHC}} x_{s,c} \leq Z_{C2}$	(6)
---	-----

$\sum_{s \in S_{Can,UHF,FP}} x_{s,HC} \geq Z_{C3}$	(7)
--	-----

2.2.5 (C5): Minimize the Interference-free Population of Canadian Full-power Stations Assigned on the Highest UHF TV Channel, Subject to the Results Obtained in (C1)–(C4).

This optimization is only done if (C3) is necessary and if Z_{C3} has a value greater than zero. It attempts to assign the Canadian full-power stations to the to the highest UHF TV channel with the minimum sum of interference-free populations.

Constants

pop_s is the interference-free population of station s .

Model Formulation for (C5):

$$\min Z_{C5} = \sum_{s \in S_{Can,UHF,FP}} pop_s x_{s,HC}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
---	---------

$\sum_{s \in S_{Can,UHF,FP}} \sum_{c \in C_S^{600UHC}} x_{s,c} \leq Z_{C1}$	(5)
---	-----

$\sum_{s \in S_{Can,UHF,LP}} \sum_{c \in C_S^{600UHC}} x_{s,c} \leq Z_{C2}$	(6)
---	-----

$\sum_{s \in S_{Can,UHF,FP}} x_{s,HC} \geq Z_{C3}$	(7)
--	-----

$\sum_{s \in S_{Can,UHF,LP}} x_{s,HC} \geq Z_{C4}$	(8)
--	-----

2.2.6 Complete set of Canadian constraints determined by solving (C1)–(C5)

$$\sum_{s \in S_{Can,UHF,FP}} \sum_{c \in C_s^{600UHC}} x_{s,c} \leq Z_{C1} \quad (5)$$

$$\sum_{s \in S_{Can,UHF,LP}} \sum_{c \in C_s^{600UHC}} x_{s,c} \leq Z_{C2} \quad (6)$$

$$\sum_{s \in S_{Can,UHF,FP}} x_{s,HC} \geq Z_{C3} \quad (7)$$

$$\sum_{s \in S_{Can,UHF,LP}} x_{s,HC} \geq Z_{C4} \quad (8)$$

$$\sum_{s \in S_{Can,UHF,FP}} pop_s x_{s,HC} \leq Z_{C5} \quad (9)$$

Constraint (9) ensures that the sum of interference-free populations of Canadian full-power stations assigned to the highest UHF TV channel is less than or equal to the minimum amount found in (C5).

2.3 Optimizations to Assign US Participating Stations to a Relinquishment Option

Once the Canadian constraints have been determined, the clearing target optimization attempts to ensure that as many US stations as possible will be able to bid in the auction and are initially assigned to the relinquishment option they selected during the initial commitments process. There are four such optimizations. Given the limited capacity of the VHF bands, it may not be possible to assign all participating bidders to their preferred relinquishment option. That is, if more bidders prefer a move to low-VHF or a move to high-VHF than can be accommodated in those bands, then the optimization procedure must initially assign some bidders to an alternative commitment option or their pre-auction band. If some participating stations *only* select a move to a VHF band in their initial commitments and the optimization does not assign them a channel in that VHF band, they will be assigned a channel in their pre-auction band and will not be able to bid in the auction.

- (US1): Determine the minimum number of UHF participating stations that must be assigned to their pre-auction band, subject to the results obtained in (C1) through (C5).
- (US2): Determine the minimum number of VHF participating stations that must be assigned to their pre-auction band, subject to the results obtained in (US1) and (C1) through (C5).
- (US3): Determine the maximum number of participating stations that can be assigned to their preferred relinquishment option, subject to the results obtained in (US1) through (US2) and (C1) through (C5).
- (US4): Determine the maximum number of participating stations that can be assigned to go off-air as an alternative to their preferred relinquishment option, subject to the results obtained in (US1) through (US3) and (C1) through (C5).

Once all four optimizations are completed, the procedure adds the outcomes of (US1) through (US4) and (C1) through (C5) as constraints to the primary, secondary, tertiary, and, if necessary, quaternary clearing target optimizations.

The optimizations outlined above ensure an initial feasible assignment of stations in the event that all participating stations cannot be assigned to their preferred options. The following section provides the mathematical formulations of the optimization models solved in (US1) through (US4) to generate a set of constraints that will be added to the primary clearing target optimization models.

2.3.1 (US1): Minimize the number of UHF stations assigned to their pre-auction band.

In (US1), the optimization seeks a feasible solution that minimizes the number of UHF participating stations that must be assigned to their pre-auction band rather than being given the option of bidding in the auction. The constraints for this first optimization are the feasibility constraints, (1) through (4), plus those needed to satisfy requirements with Canada, (5) through (9). In addition to the variables and sets defined in those sections, subsets of the sets S and C_s are defined here.

Subsets:

S_P is the set of participating U.S. stations.

S_{P_U} is the set of participating U.S. stations whose pre-auction band is UHF.

C_s^H is the set of allowable pre-auction band channels for station s , where station s is a U.S. station.

Model Formulation for (US1):

$$\min Z_{US1} = \sum_{s \in S_{P_U}} \sum_{c \in C_s^H} x_{s,c}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
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Canadian Constraints (see Section 2.2.6)	(5)-(9)
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The objective function minimizes the number Z_{US1} of UHF participating bidders that are assigned to their pre-auction band. Thus, the optimization determines the minimum number of participating stations whose pre-auction band is UHF ($s \in S_{P_U}$) that must be assigned some channel in their pre-auction band ($c \in C_s^H$), considering all stations and their allowable channels and relinquishment options. The value of Z_{US1} will be an integer greater than or equal to zero.

2.3.2 (US2): Minimize VHF stations assigned to their pre-auction band.

(US2) attempts to minimize the number of participating U.S. VHF stations assigned to their respective pre-auction bands, while ensuring that the assignment is feasible and the number of participating UHF stations assigned to their pre-auction band is no more than that found in (US1). The constraints for the optimization in (US2) are those defined in (US1) with the result of (US1) added as an additional constraint. In addition to the variables and sets defined in (US1), an additional subset of the set S is defined here.

Subsets:

S_{P_V} is the set of participating U.S. stations whose pre-auction band is VHF.

Model Formulation for (US2):

$$\min Z_{US2} = \sum_{s \in S_{P_V}} \sum_{c \in C_s^H} x_{s,c}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
---	---------

Canadian Constraints (see Section 2.2.6)	(5)-(9)
--	---------

$\sum_{s \in S_{P_U}} \sum_{c \in C_s^H} x_{s,c} \leq Z_{US1}$	(10)
--	------

Constraint (10) states that the number of the participating U.S. UHF stations assigned to their pre-auction band must be less than or equal to the count obtained in the previous optimization, Z_{US1} .

The objective function minimizes the number Z_{US2} of participating U.S. VHF stations that are assigned to their pre-auction band. Thus, the optimization determines the minimum number of participating U.S.

stations whose pre-auction band is VHF ($s \in S_{PV}$) that must be assigned a channel in their pre-auction band ($c \in C_s^H$), considering all stations and their allowable channels and relinquishment options and the minimum number Z_{US1} of UHF stations that must be assigned to their pre-auction band. The value of Z_{US2} will be an integer number greater than or equal to zero.

2.3.3 (US3): Maximize the number of stations assigned to their preferred relinquishment option

(US3) attempts to maximize the number of participating U.S. stations that are assigned to their preferred relinquishment option, while ensuring that the assignment is feasible and the number of stations assigned to their pre-auction band is no more than the minimums found in (US1) and (US2). An additional subset of the set C_s is defined here.

Subset:

C_s^{pref} is the set of allowable channels for a participating U.S. station s in its preferred option.

Note: For stations whose preferred option is to go off-air, the set C_s^{pref} consists solely of 0.

Model Formulation for (US3):

$$\max Z_{US3} = \sum_{s \in S_P} \sum_{c \in C_s^{pref}} x_{s,c}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
Canadian Constraints (see Section 2.2.6)	(5)-(9)
$\sum_{s \in S_{PU}} \sum_{c \in C_s^H} x_{s,c} \leq Z_{US1}$	(10)
$\sum_{s \in S_{PV}} \sum_{c \in C_s^H} x_{s,c} \leq Z_{US2}$	(11)

Constraint (11) states that the sum of the VHF participating U.S. stations assigned to their pre-auction band must be less than or equal to the result of the second optimization, namely the value Z_{US2} .

The objective function maximizes the total number Z_{US3} of participating stations that are assigned to their preferred option. The value of Z_{US3} will be an integer greater than or equal to zero.

2.3.4 (US4): Maximize the number of stations assigned to their option of going off the air

If it is not possible to assign all participating stations to their preferred relinquishment option, (US4) seeks to maximize the number of participating stations assigned to going off the air as an alternative option. Being initially assigned the option to go off the air, rather than being assigned to another band, will ensure that as many of the stations assigned to an alternative option as possible have the flexibility to move to bid for their other relinquishment options during the reverse auction.

The optimization model solved in (US4) determines a feasible assignment and assigns as many participating stations as possible to go off the air given the constraints that (a) there cannot be more than Z_{US1} UHF participating stations assigned to channels in the UHF band, (b) there cannot be more than Z_{US2} VHF participating stations assigned to pre-auction band channels in the VHF band, and (c) at least Z_{US3} participating stations are assigned to their preferred option.

Model Formulation for (US4):

$$\max Z_{US4} = \sum_{s \in S_P} x_{s,0}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
---	---------

Canadian Constraints (see Section 2.2.6)	(5)-(9)
--	---------

$\sum_{s \in S_{PU}} \sum_{c \in C_s^H} x_{s,c} \leq Z_{US1}$	(10)
---	------

$\sum_{s \in S_{PV}} \sum_{c \in C_s^H} x_{s,c} \leq Z_{US2}$	(11)
---	------

$\sum_{s \in S_P} \sum_{c \in C_s^{pref}} x_{s,c} \geq Z_{US3}$	(12)
---	------

Constraint (12) requires that the number of participating stations assigned to their preferred option must be greater than or equal to the result of the third optimization, namely the value Z_{US3} .

The objective function maximizes the number Z_{US4} of participating stations that are assigned to go off the air. The value of Z_{US4} will be an integer greater than or equal to zero.

2.3.5 Complete set of U.S. Participation Constraints as determined by solving (US1)-(US4)

$\sum_{s \in S_{PU}} \sum_{c \in C_s^H} x_{s,c} \leq Z_{US1}$	(10)
---	------

$\sum_{s \in S_{PV}} \sum_{c \in C_s^H} x_{s,c} \leq Z_{US2}$	(11)
---	------

$\sum_{s \in S_P} \sum_{c \in C_s^{pref}} x_{s,c} \geq Z_{US3}$	(12)
---	------

$\sum_{s \in S_P} x_{s,0} \geq Z_{US4}$	(13)
---	------

Constraint (13) requires that the number of participating stations assigned to their alternative option to go off-air must be greater than or equal to the result of the fourth optimization, namely the value Z_{US4} .

2.4 Primary Clearing Target Optimization

The next step in determining an initial assignment of participating and non-participating stations is to solve the primary clearing target optimization, which minimizes the impact of impairing TV stations to forward auction licenses, given a specified clearing target and subject to feasibility constraints and the results of (C1) through (C5) and (US1) through (US4). Thus, constraints (1) through (13) above are included in all of the subsequent optimizations. The primary clearing target optimization model seeks a feasible assignment of stations such that the sum of impaired weighted-pops across all licenses in the 600 MHz Band is minimized.

Because of the recently signed *Canadian Coordination Agreements*, there are two components to this primary optimization procedure. (P1) minimizes the maximum country-specific impairment percentage. Thus, the optimization calculates the sum of impaired weighted-pops across all licenses in that country divided by the population of the country. This optimization tries to push the maximum percentage interference of *each* country to be below the near-nationwide standard set for that clearing target.⁹ (P2)

⁹ *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9001, para. 39 fig.2 (listing the near-nationwide impairment threshold for each clearing target).

then minimizes the sum of impaired weighted-pops across all licenses in both countries, while making sure that neither country has a weighted-pop interference percentage that is greater than the impairment percentage computed in (P1) or the near-nationwide standard, whichever is greater. The results of these two optimizations work to ensure that each country's impairment level is below the near-nationwide standard set for the clearing target and that total impaired weighted-pops are minimized.

It is possible that if the results of the primary clearing target optimizations indicate that one or both countries do not satisfy the near-nationwide threshold needed for that clearing target, the threshold may be satisfied when using the more precise 2km x 2km grid calculation (rather than the county-aggregated methodology). For this reason, regardless of the results from the primary optimization, the secondary, tertiary and, where appropriate, quaternary optimizations are performed. The final resulting assignment of stations to the 600 MHz Band then uses the *TVStudy* data to do a careful evaluation of impairments at the 2km x 2km level. These calculations determine if the clearing target threshold has been met.¹⁰ If the result of the more careful calculations do not satisfy the near-nationwide threshold for impairments, that clearing target will not be selected.

In addition to the constraints derived above and denoted (1) through (13), the primary clearing target optimization also uses the set of ISIX constraints, denoted (14) through (20) below, that determine the impairment created by assigning any station to the 600 MHz Band.¹¹ For an assignment of stations to channels, these constraints determine the percent of population considered impaired for each license, and are constructed in such a way as to avoid double counting of population where the contours of assigned TV stations overlap with each other. The ISIX constraints also ensure that a license that is more than 50 percent impaired is considered 100 percent impaired, and so will not be offered in the clock phase of the forward auction.¹²

The following are the formulations for both components of the primary clearing target optimization.

2.4.1 (P1): Minimize the maximum percentage weighted impairment incurred in each country.

(P1) minimizes the maximum of the percentage impairments incurred in the U.S. and in Canada.

Variables

$y_{a,l}$ is a decision variable which has a value of 1 if county-tile a is impaired for license l and 0 otherwise.

ρ_l is the percentage of population in license l with predicted impairment.

N_l is a binary variable which has a value of 1 if the license is more than 50 percent impaired.

MaxImpairment is the maximum of the impairment percentages incurred in the U.S. and Canada.

Set Definitions

A_l is the set of county-tiles a covered by license l which can be impaired partially or fully by at least one (facility, channel) pair.

$K = \{US, CA\}$ is the set of countries.

L is the set of licenses considered for the given clearing target; each license is defined by a clearing target, market id, and block. L contains all licenses in both the US and in Canada, since any of these licenses has the potential to be impaired.

¹⁰ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8985–86, para. 16, 8988–89, para. 21.

¹¹ For more details on the ISIX constraints, see App. B.

¹² See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9000, para. 38 n.142.

L_k is the set of licenses for country $k \in K$.

$SC_{a,l}$ is the set of impairing (facility, channel) pairs which impair county-tile a in license l .

Constants

i_l is the weighting associated with license l .

w_l is the weighted-pops associated with license l , which is equal to i_l multiplied by the population associated with license l .

$pct_{a,l}$ is the percent of license l 's population in county-tile a .

Model Formulation for (P1):

$$Z_{P1} = \min \text{MaxImpairment}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)		(1)-(4)
Canadian Constraints (see Section 2.2.6)		(5)-(9)
U.S. Participation Constraints (see Section 2.3.5)		(10)-(13)
$\sum_{a \in A_l} pct_{a,l} y_{a,l} = \rho_l$	$\forall l \in L$	(14)
$x_{s,c} \leq y_{a,l}$	$\forall (s, c) \in SC_{a,l}, a \in A_l, l \in L$	(15)
$0 \leq y_{a,l} \leq 1$	$\forall a \in A_l, l \in L$	(16)
$0 \leq \rho_l \leq 1$	$\forall l \in L$	(17)
$\rho_l \leq .5 + (.5)N_l$	$\forall l \in L$	(18)
$\rho_l \geq N_l$	$\forall l \in L$	(19)
$N_l \in \{0,1\}$	$\forall l \in L$	(20)
$\text{MaxImpairment} \geq \sum_{l \in L_k} w_l \rho_l / \sum_{l \in L_k} w_l$	$\forall k \in K$	(21)

Explanation of New Constraints:

14: Calculation of the total percent of population impaired in each license

$$\sum_{a \in A_l} pct_{a,l} y_{a,l} = \rho_l \quad \forall l \in L$$

For every license, this constraint calculates the total percent of population impaired in the license by summing the percent of population impaired with respect to the market for all the county-tiles a that have broadband service respectively in license l .

15: Constraints that set the county variables to 1

$$x_{s,c} \leq y_{a,l} \quad \forall (s, c) \in SC_{a,l}, a \in A_l, l \in L$$

For each county in each license, these constraints set the county variable to 1 when a specific (facility, channel) assignment creates impairment. Note that the value of $y_{a,l}$ remains 1 even if multiple channel assignments force the county to be impaired.

16: Constraints that restrict the value of the county variables

$$0 \leq y_{a,l} \leq 1 \quad \forall a \in A_l, l \in L$$

For each county in each license, these constraints restrict the value of the county variables to be between 0 and 1 inclusive. Note that the constraints are constructed in such a way that, when combined with the objective to minimize the sum of impaired weighted-pops (see Appendix B), these variables will take on the value 0 when the county is not impaired, or 1 when it is. As a result, the model can consider the variables to be continuous but in practice they will be binary.

17: Constraints that restrict the values of the total percent of population with predicted impairment variables

$$0 \leq \rho_l \leq 1 \quad \forall l \in L$$

For each license l , these constraints restrict the value of the total percent of population with predicted impairment variables to be between 0 and 1 inclusive. A solution value of 0 indicates that there is no predicted impairment in license l , while a value of 1 indicates that this license is predicted to be 100 percent impaired.

18: Constraints that set binary variable N_l to 1

$$\rho_l \leq .5 + .5N_l \quad \forall l \in L$$

For each license l , this constraint will force the variable N_l to be 1 whenever the calculated value of ρ_l is greater than or equal to 50 percent.

19: Constraints that set the percentage of impairment, ρ_l , to 1

$$\rho_l \geq N_l \quad \forall l \in L$$

For each license l , this constraint will set the impairment percentage of license l to be 100 percent whenever the variable N_l is set to 1. This constraint is coupled with constraint (18) to force the total impairment of the license. Thus, whenever the population impairment percentage is greater than 50 percent, the license is considered completely impaired since it will not be available in the forward auction.

20: Constraints that restrict the value of variable N_l

$$N_l \in \{0,1\} \quad \forall l \in L$$

For each license l , the variable N_l is restricted to the value 0 or 1.

21: Constraints that find the maximum impairment between the two countries

$$MaxImpairment \geq \sum_{l \in L_k} w_l \rho_l / \sum_{l \in L_k} w_l \quad \forall k \in K$$

For each country k , *MaxImpairment* must be greater than the calculated percentage impairment of each country.

2.4.2 (P2): Minimize the total amount of impaired weighted population in the U.S. and Canada.

The second component of the primary clearing target optimization minimizes the amount of impairment incurred by both countries, while maintaining that the maximum percentage of impairment in each country cannot be increased above the result of P1 or the clearing target's threshold, whichever is larger. Thus, the first minimizes the maximum impairment each country can incur and this second optimization ensures that the total weighted-pops impaired is minimized.

Constants

$threshold_{CT}$ is the threshold for a specific clearing target CT .

Model Formulation for (P2):

$$Z_{P2} = \min \sum_{l \in L} w_l \rho_l$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)		(1)-(4)
Canadian Constraints (see Section 2.2.6)		(5)-(9)
U.S. Participation Constraints (see Section 2.3.5)		(10)-(13)
$\sum_{a \in A_l} pct_{a,l} y_{a,l} = \rho_l$	$\forall l \in L$	(14)
$x_{s,c} \leq y_{a,l}$	$\forall (s,c) \in SC_{a,l}, a \in A_l, l \in L$	(15)
$0 \leq y_{a,l} \leq 1$	$\forall a \in A_l, l \in L$	(16)
$0 \leq \rho_l \leq 1$	$\forall l \in L$	(17)
$\rho_l \leq .5 + (.5)N_l$	$\forall l \in L$	(18)
$\rho_l \geq N_l$	$\forall l \in L$	(19)
$N_l \in \{0,1\}$	$\forall l \in L$	(20)
$\sum_{l \in L_k} w_l \rho_l / \sum_{l \in L_k} w_l \leq \max\{Z_{P1}, threshold_{CT}\}$	$\forall k \in K$	(21)

Explanation of New Constraint:

Constraint (21) limits the impairment percentage each country can incur to either the result of (P2) or the clearing target threshold whichever is larger.

2.4.3 Complete set of constraints associated with the Primary Clearing Target

$\sum_{a \in A_l} pct_{a,l} y_{a,l} = \rho_l$	$\forall l \in L$	(14)
$x_{s,c} \leq y_{a,l}$	$\forall (s,c) \in SC_{a,l}, a \in A_l, l \in L$	(15)
$0 \leq y_{a,l} \leq 1$	$\forall a \in A_l, l \in L$	(16)
$0 \leq \rho_l \leq 1$	$\forall l \in L$	(17)
$\rho_l \leq .5 + (.5)N_l$	$\forall l \in L$	(18)
$\rho_l \geq N_l$	$\forall l \in L$	(19)
$N_l \in \{0,1\}$	$\forall l \in L$	(20)
$\sum_{l \in L_k} w_l \rho_l / \sum_{l \in L_k} w_l \leq \max\{Z_{P1}, threshold_{CT}\}$	$\forall k \in K$	(21)
$\sum_{l \in L} w_l \rho_l \leq Z_{P2}$		(22)

Constraint (22) states that the percent total impaired weighted pops of any assignment must be less than or equal to the result obtained from (P2) of the primary clearing target optimization rounded up to the nearest integer.

2.5 Secondary Clearing Target Optimization

The next step is to determine, as a secondary objective, the maximum weighted number of Category 1 licenses in Canada and the US given that the maximum impairment cannot be greater than that determined by the primary clearing target optimization. Thus, the secondary objective will function primarily as a tie-breaker in choosing a provisional TV channel assignment plan: when more than one potential plan exists with the same minimum level of impairment as that identified by the primary objective optimization, the secondary objective will seek one that maximizes the weighted number of Category 1 licenses.

The following is the formulation of the secondary clearing target optimization.

Variables

$G_{1,l}$ is a binary variable which has a value of 1 if the licenses can be categorized as a Category 1 license based on the calculated impairment, and 0 otherwise.

Model Formulation for the Secondary Clearing Target Optimization:

$$Z_{secondary} = \max \sum_{l \in L} i_l G_{1,l}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)		(1)-(4)
Canadian Constraints (see Section 2.2.6)		(5)-(9)
U.S. Participation Constraints (see Section 2.3.5)		(10)-(13)
Primary Clearing Target Constraints (see Section 2.4.3)		(14)-(22)
$\rho_l \leq .15 + .85(1 - G_{1,l})$	$\forall l \in L$	(23)
$G_{1,l} \in \{0,1\}$	$\forall l \in L$	(24)

Explanation of New Constraints:

23: Set $G_{1,l}$ to one when license l is a Category 1 license

$$\rho_l \leq .15 + .85(1 - G_{1,l}) \quad \forall l \in L$$

Constraints (23) forces variable $G_{1,l}$ to be zero if it is not a Category 1 license.

24: $G_{1,l}$ must be binary

$$G_{1,l} \in \{0,1\} \quad \forall l \in L$$

For each license l , the variable $G_{1,l}$ is restricted to the value 0 or 1.

2.5.1 Complete set of constraints associated with the Secondary Clearing Target

$$\rho_l \leq .15 + .85(1 - G_{1,l}) \quad \forall l \in L \quad (23)$$

$$G_{1,l} \in \{0,1\} \quad \forall l \in L \quad (24)$$

$$\sum_{l \in L} i_l G_{1,l} \geq Z_{Secondary} \quad (25)$$

$$\sum_{l \in L} i_l (1 - G_{1,l} - N_l) \geq TotG_2 \quad (26)$$

Constraint (25) states that the total number of weighted Category 1 licenses may not be less than then the number found in the secondary clearing target optimization. $Z_{Secondary}$ will be rounded down to the nearest integer.

Constraint (26) states that the total number of weighted Category 2 licenses may not be less than then the number found in the result of the secondary clearing target optimization ($TotG_2$).

2.6 Tertiary Clearing Target Optimization

The provisional TV channel assignment plan determined by applying the first two objectives may include licenses that cannot be categorized as either Category 1 or Category 2 because more than 50 percent of the population is subject to impairment. The optimization procedure will apply a tertiary objective in order to maximize the potential value in a subsequent spectrum auction of these more heavily impaired licenses. More specifically, the tertiary objective will seek to minimize impaired weighted-pops over all licenses, including licenses with more than 50 percent of the population subject to impairment.¹³ The tertiary objective will be constrained by the first two objectives: it will be applied only to the extent that it neither increases the impaired weighted pops resulting from the primary optimization nor reduces the weighted number of Category 1 licenses resulting from the secondary optimization. The combined impairment percentage is rounded up to the nearest integer and the weighted number of Category 1 licenses is rounded down to the nearest integer. Further, applying the tertiary objective will not decrease the weighted number of Category 2 licenses found by applying the primary and secondary objectives.

The following is the formulation of the tertiary clearing target optimization.

Variables

ρ'_l is the percentage of population in license l with predicted impairment, while not counting licenses with predicted impairment above 50 percent as being 100 percent impaired.

Model Formulation for the Tertiary Clearing Target Optimization:

$$Z_{Tertiary} = \min \sum_{l \in L} w_l \rho'_l$$

¹³ The primary and secondary objectives will count any license with greater than 50 percent impaired weighted-pops as 100 percent impaired.

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
Canadian Constraints (see Section 2.2.6)	(5)-(9)
U.S. Participation Constraints (see Section 2.3.5)	(10)-(13)
$\sum_{a \in A_l} pct_{a,l} y_{a,l} \leq \rho_l$ (note this change in sense)	$\forall l \in L$ (14)
Primary Clearing Target Constraints (see Section 2.4.3)	(15)-(22)
Secondary Clearing Target Constraints (see Section 2.5.1)	(23)-(26)
$\sum_{a \in A_l} pct_{a,l} y_{a,l} \leq \rho'_l$	$\forall l \in L$ (27)
$0 \leq \rho'_l \leq 1$	$\forall l \in L$ (28)

Explanation of New Constraints:**27: Calculation of the total percent of population impaired in each license**

$$\sum_{a \in A_l} pct_{a,l} y_{a,l} \leq \rho'_l \quad \forall l \in L$$

For every license, Constraint (27) sets the lower bound on the total percent of population impaired in the license without counting licenses not offered in the forward auction as 100 percent impaired, by summing the percent of population impaired with respect to the market for all the county-tiles a that have broadband service respectively in license l .

28: Constraints that restrict the values of the total percent of population with predicted impairment variables

$$0 \leq \rho'_l \leq 1 \quad \forall l \in L$$

For each license l , these constraints restrict the value of the total percent of population with predicted impairment without counting licenses not offered in the forward auction as 100 percent impaired variables to be between 0 and 1 inclusive. A solution value of 0 indicates that there is no predicted impairment in license l , while a value of 1 indicates that this license is predicted to be 100 percent impaired.

2.6.1 Complete set of constraints associated with the Tertiary Clearing Target

$\sum_{a \in A_l} pct_{a,l} y_{a,l} \leq \rho'_l$	$\forall l \in L$ (27)
$0 \leq \rho'_l \leq 1$	$\forall l \in L$ (28)
$\sum_{l \in L} w_l \rho'_l \leq Z_{Tertiary}$	(29)

Constraint (29) ensures that the maximum potential value of licenses not offered in the forward auction is maintained for a subsequent spectrum auction.

2.7 Quaternary Clearing Target Optimization

For clearing targets with an 11 MHz lower guard band,¹⁴ the final step in determining an initial assignment of participating and non-participating stations is to minimize the count of stations assigned to the lowest channel in the lower guard band. We define $HC + 1$ to be the lowest channel above the highest allowable channel in the TV band for the given clearing target.

In this optimization, all stations assigned in the 600 MHz Band above $HC + 1$ will remain on their assigned channel, and no additional stations will be assigned to those channels. This will be accomplished by removing the appropriate channels from each station's domain. Therefore, there is no need to include the constraints associated with the primary, secondary, and tertiary optimizations.

The following is the full formulation of the quaternary clearing target optimization.

Model Formulation for the Quaternary Clearing Target Optimization:

$$\min Z_{\text{Quaternary}} = \sum_{s \in S} x_{s, HC+1}$$

Subject to:

Repacking Feasibility Constraints (see Section 2.1.2)	(1)-(4)
Canadian Constraints (see Section 2.2.6)	(5)-(9)
U.S. Participation Constraints (see Section 2.3.5)	(10)-(13)

3 Clearing Target Optimization during the Auction

The Clearing Target Optimization will also be used between stages in order to determine an assignment of stations consistent with the lower clearing target, which will establish forward auction license impairments for the next stage. In this section, the optimization models and their mathematical formulations are discussed.

The Clearing Target Optimization will be run between stages to account for the additional UHF channel or channels available in the television portion of the band, which will impact any channel assignments that must be made in the 600 MHz Band. Thus, before the start of a new stage, the Clearing Target Optimization software will re-shuffle the UHF band based on the new clearing target and incorporating the feasibility, Canadian Coordination, and ISIX constraints into the primary through quaternary optimizations aimed at minimizing impaired weighted-pops when assigning stations to channels in the 600 MHz Band. The reverse auction bidding system will then use the new assignment of stations as the initial assignment of UHF stations for the next stage, fixing the assignment of those stations assigned in the 600 MHz Band and keeping tentative those assigned to be repacked into the television portion of the UHF band. The forward auction will use the corresponding impairments for licenses offered in the next stage of the forward auction. A flow chart of the clearing target optimization used between stages is shown in Figure 2 below:

¹⁴ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8981, para. 5 fig.1.

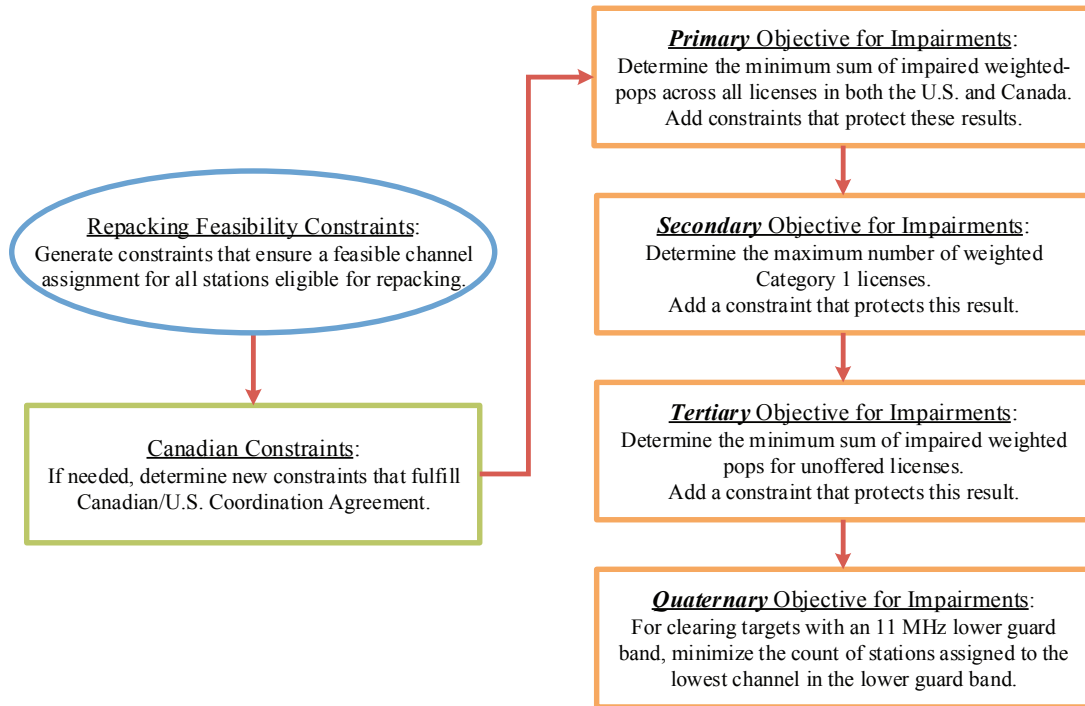


Figure 2: Between Stages Clearing Target Optimization Flow

Model Formulation

The formulation of the optimization model is the same as it is in the initial clearing target optimization with the one exception that the optimizations associated with determining constraints for the participating U.S. stations are not solved. When performing the clearing target optimization between stages, the objective is to “reshuffle” the assignment of stations to channels in the UHF band so as to minimize impaired weighted pops in the 600 MHz Band. Specifically, the clearing target optimization solved in between stages differs from the initial clearing target optimization in the following ways:

- (1) The set of stations S is reduced to stations assigned to the UHF band at the completion of the previous stage.
- (2) (US1) through (US4) do not need to be performed because all participating stations are already assigned to a relinquishment option.
- (3) (C1) through (C5) must be redone for each clearing target until it is established that all Canadian stations can be assigned to the TV band. Once it is established that $Z_{C1} = Z_{C2} = 0$ for a given clearing target, then (C1) through (C5) will not need to be performed for any lower clearing target. The domain allowed for the Canadian station will be set to include only channels below the highest UHF channel within the clearing target.
- (4) The primary, secondary and tertiary, and sometimes quaternary optimizations are performed in order to
 - reduce the total impaired weighted-pops,
 - encourage the shifting of Category 2 licenses to Category 1 licenses,
 - make available in the forward auction those licenses that were not previously, and
 - make the licenses not available in the forward auction more valuable in a future auction.

APPENDIX D

Reverse Auction Pricing and Bid Processing Algorithm

1 Introduction

This appendix explains the process for calculating price offers and vacancy indices, processing the bids made by stations, determining the bidding status of each station, and transitioning to a new stage of the reverse auction pursuant to the Commission's decision in the *Auction 1000 Bidding Procedures PN*.

Generally, the descending clock reverse auction presents stations with prices for a hierarchy of relinquishment options. For UHF stations (participating stations whose pre-auction band is UHF), the highest price offer is associated with the option to go off-air, the second-highest with the option to move to Low-VHF, and the lowest with the option to move to High-VHF. A UHF station that finds none of the price offers for these three options acceptable can drop out of bidding and continue to broadcast in the UHF band.

For High-VHF stations (participating stations whose pre-auction band is High-VHF), the auction system shows price offers for two options: the higher priced option is to go off-air and the lower priced one is to move to Low-VHF. For Low-VHF stations (participating stations whose pre-auction band is Low-VHF), the auction system shows just one price offer, which is for the option to go off-air. High-VHF and Low-VHF stations that find none of their relinquishment options acceptable can drop out of bidding and continue to broadcast in their pre-auction band.

Under the descending clock auction format, the auction system will decrement the per-volume nationwide base clock price. As with opening price offers, a UHF station will be offered a price to go off-air in each clock round that will equal the base clock price multiplied by its station-specific volume factor. Unlike opening price offers, the new price offers in clock rounds for UHF stations to move to the VHF bands, or for VHF stations to move to a lower band or go off-air, will reflect the relative availability of channels for each station in the VHF and UHF bands.

1.1 Four Design Challenges

The design of the auction balances four main challenges. The first is simplicity for the participating stations, both in terms of the mechanics of bidding and in terms of bidding strategy. Although the repacking process is unavoidably complex, the goal is to minimize the complexities of the bidder interface and to make understanding the repacking process unnecessary for effective bidding. This goal is achieved by the adoption of a "ladder clock" auction. The "clock" portion of this description means that active bidders are shown a declining sequence of prices and asked to choose their preferred option at each. The "ladder" portion of the description means that during the auction stations can only switch from lower options in the hierarchy to higher options. The order of options from lowest to highest is (1) go off-air, (2) move to Low-VHF, (3) move to High-VHF, and (4) drop out of the bidding. The bidding interface associated with a clock auction is relatively simple and the ladder structure prevents bidders from moving back and forth between options, thereby eliminating complex bidding strategies. This makes bidding easier for bidders and also gives the auction system more reliable information to use in setting price offers.¹

The second challenge is to set price offers for the UHF stations in a way that recognizes and accommodates the differences in interference patterns and channel availability in UHF, High-VHF, and Low-VHF that are found between stations in different places, including ones between stations that are near neighbors. In every round, the auction system sets the same price offer per unit of volume (the "base

¹ In the auction system, price offers are referred to as clock prices.

clock price”) for the off-air option for all UHF stations across the whole country. The mathematical formula for computing price offers for all the other options of UHF stations is designed to promote a balance of supply and demand for each option in the neighborhood of each station.

The third challenge is to maintain a proper relationship between the prices offered to UHF stations and the ones offered to VHF stations, when closely comparable stations are available. For example, if the prices offered to a UHF station for the options to go off-air, move to Low-VHF, and move to High-VHF are $\$X$, $\$Y$, and $\$Z$, respectively, what prices should be offered to nearby VHF stations? This is easiest to answer for the case when there are three stations: a UHF station, a High-VHF station, and a Low-VHF station, that serve exactly the same population and have the property that if the UHF station were to move into either of the two VHF bands, it would create exactly the same interference constraints on neighboring stations, and similarly if the High-VHF station were to move into the Low-VHF band, it would create exactly the same interference constraints as the Low-VHF station. In such a case, there are four ways to clear the UHF channel. These possibilities are listed below alongside the VHF price offers. These VHF price offers have the property that the total price of clearing a UHF channel always equals the price $\$X$, regardless of which moves are required to achieve the clearing.

1. The UHF station could go off-air at a price offer of $\$X$.
2. The UHF station could move to Low-VHF at a price offer of $\$Y$ (where $\$Y < \X), and the Low-VHF station could go off-air at a price offer of $\$X - \Y .
3. The UHF station could move to High-VHF at a price offer of $\$Z$ (where $\$Z < \Y), and the High-VHF station could go off-air at a price offer of $\$X - \Z .
4. The UHF station could move to High-VHF at a price offer of $\$Z$; the Low-VHF station could go off-air at a price offer of $\$X - \Y ; and the High-VHF station could move to Low-VHF at a price offer of $\$Y - \Z .

This relationship is illustrated in the following figure:

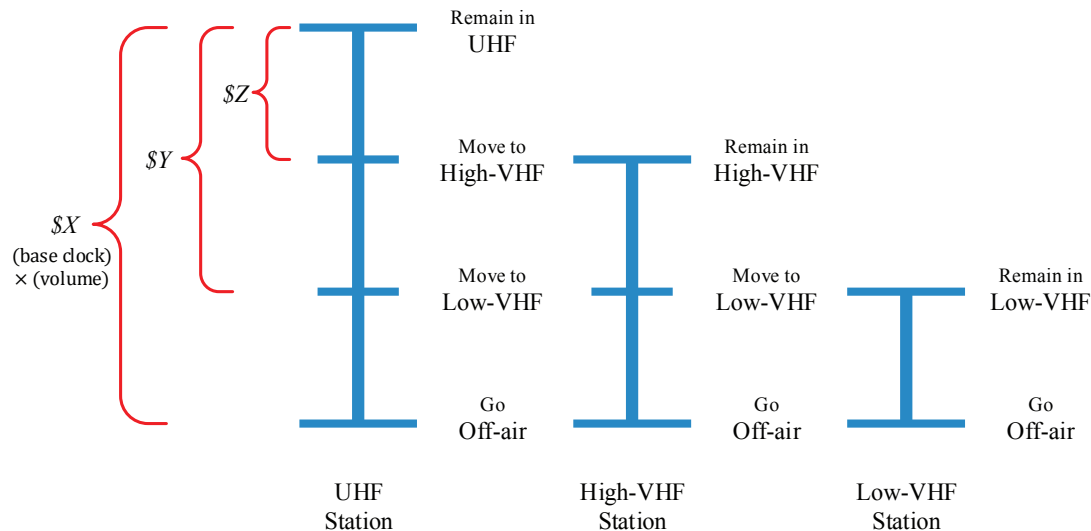


Figure 3: Prices for each pre-auction band relative to the UHF prices

The fourth and final challenge is to set appropriate price offers for VHF stations for which there is no exactly comparable UHF station. This is accomplished by the use of *benchmark prices*, that is, we compute the hypothetical price offers per unit of volume, $\$x$, $\$y$ and $\$z$, that would apply to an exactly comparable UHF station if there were such a station. The auction system uses those benchmark prices to set the price offers for VHF stations. For compactness, this appendix uses the term “benchmark prices” to refer to the UHF prices per unit of volume for both actual UHF stations and the possibly imaginary

stations used in the VHF price computations. The *base clock price* is the benchmark price to go off-air for a UHF station. A $(\text{base clock price}) \cdot (\text{volume})$

For every station in every round, the algorithm sets the price offers by first determining the appropriate benchmark prices and then deriving appropriate prices per unit of volume for each option. The auction system then multiplies those prices by the volume of the individual station to obtain the price offers in every round. The volume of each station is determined using its covered population and an index of the number of interference constraints in which the station participates, as described in Section 2.6.

1.2 Conducting the Bidding Rounds

Before a bidding round begins, the auction system announces to each station its *bidding status*, *currently held option*, and *current price*, as well as price offers for every relinquishment option available to it. The auction system collects bids during the bidding round. After each round, the auction system processes the collected bids and updates the *currently held option* and the *current price* of each station.

If, after processing the bids from a round, every participating station has either dropped out of the bidding (“exited”) or become provisionally winning, the current stage of the reverse auction ends and the incentive auction proceeds with the forward auction for that stage. Otherwise, the auction system updates the price offers for each station and a new round begins.

1.3 Winners and Winning Prices

A provisional winner in a stage of the reverse auction becomes a *winner* if the final stage rule is satisfied for the current stage of the auction. In that event, the provisional winner’s current relinquishment option will be its winning option, and its provisionally winning price will be its winning price. If the final stage rule is not satisfied, however, then the clearing target will be reduced and the system will determine which provisional winners will be returned to the status of active stations at the beginning of the next stage as a result of the additional channels available in the television portion of the UHF band.

2 Notation and Definitions

This section describes the notation and definitions that are used in the following sections.

2.1 Currently Held (Relinquishment) Option and Current Price

The currently held option of station s in round t , denoted by $b_{t,s}$, is the relinquishment option that the station is tentatively assigned to at the start of round t . The current price of station s in round t , denoted by $\hat{P}_{t,s}$, is the compensation the station is tentatively given at the start of round t . For a station that has dropped out of the auction, its currently held option is its pre-auction band and its current price is zero.

For the first round of the auction, the currently held option of station s (denoted $b_{1,s}$) is determined by the initial clearing target optimization.² The current price $\hat{P}_{1,s}$ of station s is then set to be equal to the station’s opening price for $b_{1,s}$.

For any round after the first round of the auction, the currently held options and current prices of stations are determined by the bid processing of the previous round.³

² For details on the clearing target optimization, see App. C.

³ If it is determined that a station is not needed before a new stage of the reverse auction, see App. J, then at the beginning of a new stage, the station’s currently held option is set to be its pre-auction band and its current price is set to zero.

2.2 Bidding Status

The bidding status of each station will be one of the following:

- (1) *bidding*⁴
- (2) *frozen – provisionally winning*
- (3) *frozen – currently infeasible*
- (4) *frozen – pending catch up*
- (5) *exited – voluntary*
- (6) *exited – not needed*

A station is *frozen* either if the auction system has determined that the station is infeasible in its pre-auction band or if the base clock has not caught up to the station's "catch up point" in the early rounds of a new stage. A station that is frozen at the beginning of a bidding round is not asked to bid in that round.

Moreover, during the initial rounds of a new stage (see Section 7), the status of a VHF station that is currently infeasible in its pre-auction band and is pending catch up will be "frozen – pending catch up."

Finally, a station is considered *active* if its status is "bidding," "frozen – currently infeasible" or "frozen – pending catch up." Equivalently, all participating stations that have *not* exited or become provisional winners are active. Even if currently frozen, an active station may be asked to bid later in the stage.

2.3 Ordering of Relinquishment Options and Bands

For the purposes of this appendix, the order of possible assignments for a station is (1) off-air, (2) Low-VHF, (3) High-VHF and (4) UHF, with the understanding that these numbers are also used to describe the ordering of bands and options from lowest to highest. The notation $b < b'$ is used to denote that band b is strictly below band b' in this ordering and the notation $b \leq b'$ is used to denote that either b and b' are the same band or band b is below band b' .

2.4 Highest Available Channels

The FCC and Industry Canada will jointly repack TV stations.⁵ The following table shows for each clearing target, the highest available channel for US and Canadian stations. The Canadian highest available channel will generally be equal to the US highest available channel minus 1. The only exception is the 78 MHz clearing target at which the US highest available channel is channel 38 and the Canadian highest available channel is channel 36, because no station can be placed on channel 37.

⁴ This status was referred to as "bidding in the current round" in the *Auction 1000 Procedures PN*. See *Broadcast Incentive Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, GN Docket No. 12-268, AU Docket No. 14-252, 30 FCC Rcd 8975, 9040, para. 124 (2015) (*Auction 1000 Bidding Procedures PN*). To avoid confusion with regard to which round is the current round, we will use the shortened status "bidding" throughout this appendix and in the auction system software.

⁵ *Statement of Intent Between the Federal Communications Commission of the United States of America and the Department of Industry Canada Related to the Reconfiguration of Spectrum Use in the UHF Band for Over-the-Air Television Broadcasting and Mobile Broadband Services*, U.S.–Can., Aug. 11, 2015, available at <https://transition.fcc.gov/ib/sand/agree/files/PASHC.pdf> (Canadian Coordination).

Clearing target	US highest available channel	Canadian highest available channel
126 megahertz ⁶	29	28
114 megahertz	31	30
108 megahertz	32	31
84 megahertz	36	35
78 megahertz	38	36
72 megahertz	39	38
60 megahertz	41	40
48 megahertz	43	42
42 megahertz	44	43

2.5 Assignments and Feasibility

A channel assignment plan specifies a particular channel for each station that is not currently holding the option to go off-air. Such a plan is feasible if:

- 1) Each non-participating station is assigned to a channel in its pre-auction band;
- 2) Each exited station is assigned to a channel in its pre-auction band;
- 3) Every other station is assigned to a channel consistent with its currently held option;
- 4) Every station is assigned a channel at or below the highest available channel in its country (see Section 2.4), except for those deemed as impairing for this stage, which are assigned channels in the 600 MHz Band; and
- 5) Each station is assigned to one of its allowable channels, as defined in the *domain.csv* file.
- 6) Station-channel assignments must not violate adjacent and co-channel pairwise interference restrictions as defined in the *interference_paired.csv* file.

The *current tentative assignment* used by the auction system describes, for each station, the band and channel to which it is tentatively assigned. Given a current tentative assignment, a station is said to be *feasible in band b* if the system can find a feasible channel assignment plan in which that station is assigned to a channel in band *b* and the other stations are assigned to channels in the same bands as in the current tentative assignment.

2.6 Calculating Volume

Consistent with the *Auction 1000 Bidding Procedures PN*,⁷ the volume of each station *s* will be calculated using this formula:

$$VOLUME(s) = A \cdot (Population(s))^{0.5} \cdot (Interference(s))^{0.5}$$

In this formula, *A* is a scaling constant, which is chosen for convenience so that the largest volume for any station is one million; *Population(s)* is the number of people residing within the interference-free service area of station *s*;⁸ and *Interference(s)* is an index of the number and significance of co- and

⁶ See § III.A.2 (International Coordination) and note 135 of the Public Notice.

⁷ *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9017, para. 65.

⁸ A station's interference-free population can be obtained from the *baseline.csv* file generated by *TVStudy*. We have also included this information in App. I as the final Pre-Auction Baseline Data file.

adjacent channel interference constraints that station s would impose on repacking. The computation of this index is described below.

2.6.1 Determining the Interference Component

For each pair of stations (i, j) and channel c , let O_{ij}^c be a count of the number of the applicable adjacent-channel or co-channel interference constraints as further defined below. $O_{ij}^c = 0$ indicates that there is no applicable interference constraint limiting the assignment of i to channel c and j to channel c or $c - 1$ or $c + 1$; $O_{ij}^c = 1$ indicates that one such constraint is applicable; $O_{ij}^c = 2$ indicates that two such constraints are applicable; and $O_{ij}^c = 3$ indicates that three such constraints are applicable.⁹ O_{ij}^c is always 0, 1, 2, or 3. $O_j^i = \max_{c \in C_{ij}} \{O_{ij}^c\}$, which is the maximum of O_{ij}^c over the set C_{ij} of *relevant channels*, is defined to index the potential interference between stations i and j . The relevant channels for any pair of stations are determined as follows.

- Between two UHF stations, the relevant channels are all the channels in the UHF, High-VHF and Low-VHF bands (channels 2–51).
- Between a UHF station and a High-VHF station or between two High-VHF stations, the relevant channels are those in the High-VHF band (channels 7–13) and Low-VHF band (channels 2–6).
- Between a UHF or High-VHF station and a Low-VHF station or between two Low-VHF stations, the relevant channels are those in the Low-VHF band (channels 2–6).

The interference index for station i is $Interference(i) = \sum_j O_j^i$.

3 Calculation of Price Offers

Before the start of each round t , the system calculates price offers for this round for every station with “bidding” or “frozen – currently infeasible” status. A price offer is calculated for each relinquishment option that is at or above the station’s currently held option and that the station has indicated it is willing to consider in its application.

In round t , the base clock price (or equivalently, the benchmark price for the off-air option of a UHF station) will be decremented by:

$$d_t := \max\{R_1 \cdot c_{t-1}, R_2 \cdot p_{0,OFF}\}$$

Where c_{t-1} denotes the base clock price in round $t - 1$ and $p_{0,OFF}$ denotes the base clock price at the beginning of the auction (the opening base clock price). R_1 and R_2 are parameters with default values $R_1 = 5\%$ and $R_2 = 1\%$.

In words, the decrement for round t is equal to the maximum of (i) R_1 times the base clock price in the previous round, and (ii) R_2 times the opening base clock price.

The price offer of a UHF station for the off-air option will be decremented by the product of the decrement (d_t) and the station’s volume.

To calculate the price offers for VHF stations and for the VHF options available to UHF stations, the system first updates the stations’ benchmark prices using vacancy information. A larger vacancy value in band b indicates that band b is relatively less congested in the station’s neighborhood, given the currently held options of every station. Vacancies are used to guide price reductions. The larger a station’s

⁹ This data is available in the *interference_paired.csv* file, which is available at <http://wireless.fcc.gov/incentiveauctions/learn-program/repacking.html/>.

vacancy in a VHF relinquishment option, the less the benchmark price of that relinquishment option will be reduced.

The round's price offers for a station s (that is either "bidding" or "frozen – currently infeasible") are then calculated from its benchmark prices and its volume. The price offer for each relinquishment option b of a UHF station will be calculated as the product of the station's volume and its benchmark price for option b . The price offer for a station whose pre-auction band is a VHF band b' (which may be Low-VHF or High-VHF) will be set for each relinquishment option b as the product of the station's volume and the difference between its benchmark prices for options b and b' . A caveat to this is that for all stations and all options, the price offer will never exceed the product of a station's volume and its benchmark price for the option to go off-air.

The price offer calculations are described in detail in the following sections. Sections 3.1 and 3.2 define two notions that are used in the vacancy definition in Section 3.3. To calculate the price offers for round t , the system first calculates vacancies (Section 3.3) and reduction coefficients (Section 3.4) for the station. A station's benchmark prices are calculated from the price decrement and its reduction coefficients, as described in Section 3.5. The round's price offers are then calculated from the benchmark prices, as described in Section 3.6.

3.1 Permissible Options

Band b is *permissible* for station s if either:

- (i) Band b is the pre-auction band of station s ; or
- (ii) Band b is below the station's pre-auction band according to the ordering described in Section 2.3.

The set of permissible options for station s includes all its permissible bands and the option to go off-air. For example, the permissible options of a High-VHF station are $\{Off-Air, Low-VHF, High-VHF\}$.

3.2 Neighborhood of Station s in Band b

The *neighborhood* of station s in band b is the set of active stations, including station s , that could interfere with the station in band b and therefore potentially limit assigning the station to an available channel in that band.

For instance, the neighborhood of station s in High-VHF includes station s and all stations that interfere with station s in High-VHF.

Example:

Suppose there are four active stations: $\{1,2,3,4\}$. The following pairs of stations have adjacent-channel interference constraints in band b : $(1,2)$, $(2,3)$, $(3,4)$. There are no other interference constraints between the stations. Then, the neighborhood of station 1 in band b is $\{1,2\}$, and the neighborhood of station 2 in band b is $\{1,2,3\}$.

3.3 Vacancy

Before each bidding round t , for each active station s and band b , the auction system calculates the vacancy $V_{t,s,b}$, which is a number greater than 0 and less than or equal to 1. Vacancy is the opposite of congestion: a larger value of $V_{t,s,b}$ indicates that band b is relatively less congested in the station's neighborhood, given the currently held options for every station. The vacancy is calculated as a weighted average, as follows:

- $f(t, s, b) = X/M_b$, where X is the maximum of (1) the number of channels in band b to which station s can be feasibly assigned given the current tentative assignment, and (2) the parameter

VAC_FLOOR ; and M_b is the number of channels in band b . The parameter VAC_FLOOR will be set to be equal to 0.5.

- $G(t, s, b)$ is a set consisting of all stations in the neighborhood of station s in band b whose currently held option is below band b , and for which band b is a permissible band. (These stations are implicitly understood to be the potential competitors for station s for the remaining vacant spaces in band b .)

If band b is above the pre-auction band of station s and the station's benchmark price for its pre-auction band in the previous round was nonpositive then let $V_{t,s,b} = VAC_FLOOR/M_b$. If $G(t, s, b)$ is an empty set, then let $V_{t,s,b} = 1$. Otherwise, let

$$V_{t,s,b} = \frac{\sum_{s' \in G(t,s,b)} VOLUME(s') \cdot f(t, s', b)}{\sum_{s' \in G(t,s,b)} VOLUME(s')}$$

3.4 Reduction Coefficients

The auction system uses the calculated vacancy for each station in each band to compute *reduction coefficients*, denoted as $r_{t,s,b}$, which determine the relative price reductions in the benchmark prices of moving to the VHF bands compared to the reduction in the benchmark price to go off-air. For bands $b = \text{Low-VHF (LV)}$, High-VHF (HV) the reduction coefficients are computed as follows:

- The reduction coefficient for the option to move to High-VHF is:

$$r_{t,s,HV} = \frac{p_{0,HV} \cdot (V_{t,s,UHF})^{0.5}}{(p_{0,OFF} - p_{0,HV}) \cdot (V_{t,s,HV})^{0.5} + p_{0,HV} \cdot (V_{t,s,UHF})^{0.5}}$$

- The reduction coefficient for the option to move to Low-VHF is:

$$r_{t,s,LV} = \frac{(p_{0,LV} - p_{0,HV}) \cdot (V_{t,s,HV})^{0.5}}{(p_{0,OFF} - p_{0,LV}) \cdot (V_{t,s,LV})^{0.5} + (p_{0,LV} - p_{0,HV}) \cdot (V_{t,s,HV})^{0.5}} (1 - r_{t,s,HV}) + r_{t,s,HV}$$

Each reduction coefficient is greater than 0 and less than or equal to 1.

Note that $p_{0,b}$ denotes the opening benchmark price for option b .

3.5 Benchmark Prices for Round t

In round t , the benchmark price of station s for option or band b is denoted by $p_{t,s,b}$. The benchmark prices of all stations for round 0 are set equal to the opening benchmark prices of UHF stations, that is, $p_{0,s,b} = p_{0,b}$ for every station s , irrespective of its pre-auction band. Note that $p_{t,s,UHF} = 0$ for all rounds t and all stations s , because any UHF station s that is assigned to continue UHF broadcasting receives zero compensation.

The benchmark price to go off-air in round t for a station s (with status “bidding” or “frozen – currently infeasible”) is computed as:

$$p_{t,s,OFF} = p_{t-1,s,OFF} - d_t$$

This implies that the benchmark price to go off-air for a station that is either “bidding” or “frozen – currently infeasible” will be equal to the base clock price.

The benchmark prices for bands $b = LV, HV$ are computed as:

$$p_{t,s,b} := p_{t-1,s,b} - r_{t,s,b} \cdot d_t.$$

Thus, the benchmark price for each VHF option is reduced by a station-specific fraction (equal to the reduction coefficient) of the reduction of the benchmark price of the option to go off-air.

3.6 Price offers for Round t

The price offer of station s for option b in round t is denoted by $P_{t,s,b}$. The price offers are calculated from the benchmark prices $p_{t,s,b}$ for each option b as follows:

$$P_{t,s,b} = VOLUME(s) \cdot \max\{0, \min\{p_{t,s,OFF}, p_{t,s,b} - p_{t,s,PRE-AUCTION_BAND(s)}\}\}$$

According to this formula, the per-volume price for a VHF station for an option b is less than that of an otherwise identical UHF station. The difference is equal to the UHF station's benchmark price for moving into the VHF station's pre-auction band, so that the price offer for a UHF station to move to a VHF band plus the price offer for an otherwise identical station in the VHF band to go off-air equals the price offer for the UHF station to go off-air. The price offer for each option is bounded above by the base clock price and bounded below by zero. Price offers are rounded down to the nearest integer.

4 Bidding

4.1 Bidding Rules

Stations may submit bids electronically over a web interface. Stations may only submit bids when a round is open. Only stations with the status “bidding” may submit bids.

A station may only bid for the relinquishment options that it indicated it is willing to consider in its application to participate in the auction. A station cannot submit a bid for a relinquishment option that is below its currently held option.

In each bidding round $t \geq 1$, each station s will see its currently held option $b_{t,s}$ and its current price $\hat{P}_{t,s}$ for that option (see Section 2.1 for the definitions). Each station s with the status of “bidding” is presented price offers $P_{t,s,b}$ for all relinquishment options b at or above the station's currently held option (that is, ones for which $b \geq b_{t,s}$) that the station indicated it is willing to consider on its application. The station is also given the option to drop out of the auction and receive no compensation. The station submits its preferred option at the round's price offers. If the station's preferred option is neither its currently held option nor to drop out of the auction (that is, the station's preferred option is to move to a relinquishment option in a VHF band that is not its currently held option), the station is asked to select a *fallback option* to apply if the station cannot be accommodated in the new band, and which can be either to continue in its currently held option with the price offer $P_{t,s,b_{t,s}}$ presented in round t or to drop out.

Even though a station with the status “frozen – currently infeasible” is not asked to bid in the round, the station is presented price offers $P_{t,s,b}$ for all relinquishment options b at or above its currently held option (that is, ones for which $b \geq b_{t,s}$) that the station indicated it is willing to consider in its application. This way a station with status “frozen – currently infeasible” is informed about how low its price offers have become since the round that the station was asked to bid for the last time. Note that the station's current price does not change while its status is “frozen – currently infeasible”.

4.2 Proxy Bidding

A station is allowed to submit a proxy instruction to bid for its currently held option, provided that the station does not select a different bidding option as its preferred option in the current bidding round. A proxy bid instruction is interpreted as a permission for the auction system to automatically bid for the

station's currently held option on behalf of the station as long as the corresponding price offer exceeds the proxy bid price. In order to submit a proxy bid instruction, the bidding round should be open and the station should be active; that is, the station's status should be "bidding," "frozen – currently infeasible," or "frozen – pending catch up."

The specified proxy bid price cannot be lower than a certain percentage of the current price offer. This percentage is a parameter that is set by the Commission and may change throughout the auction; its default value is 75%.

A station will be able to revise or cancel its proxy bid instruction while the proxy bid instruction is still in effect provided that (1) a bidding round is open, and (2) the station is active in the current bidding round.

An applicable proxy bid instruction changes the default behavior of the auction system in case a station with the status "bidding" fails to submit a bid in a given round. In such cases, if the proxy price is equal to or below the current price offer, the auction system will treat the proxy bid instruction as a bid for the station to continue with its currently held option. Absent an applicable proxy bid instruction, a "bidding" station that does not submit a bid during the round will be treated as having submitted a bid to drop out.

If stage $u - 1$ fails to satisfy the final stage rule and thus the incentive auction proceeds with stage u , proxy bid instructions from stage $u - 1$ do not carry over to stage u . A station that wishes to have a proxy bid instruction in place for the new stage must submit that instruction in the new stage.

5 Bid Processing and Bidding Status Updating

5.1 Missing Bids

If a station with the status "bidding" did not enter a bid during a round and did not have an applicable proxy bid instruction submitted in prior rounds, it will be deemed to have submitted a bid to drop out of the auction. That is, the system will assume that the station's preferred option at its price offers for this round is to drop out of the auction. If the station has submitted a proxy bid instruction applicable to this round, the auction system will follow that instruction (see Section 4.2).

5.2 Bid Processing

To process the bids, all stations with the status "bidding" are placed in a queue in order of the following ratio:

$$\frac{\hat{P}_{t,s} - P_{t,s,b_{t,s}}}{Volume(s)}$$

Note that the numerator represents the difference between the station's current price at the beginning of round t and its current price offer for its currently held option in round t .

After each round, the bids of stations that were "bidding" are prioritized first in order of the ratio above (from highest to lowest) across all stations, and then using a bid-specific pseudorandom number (from lowest to highest). The priority ordering of bids remains the same throughout bid processing of a round (that is, only one pseudorandom number is associated with a given bid/station in a round).

The auction system then repeats the following steps until the queue contains no stations that were determined to be feasible within a computation deadline:

- Find the first station s in the queue that is proved to be feasible in its pre-auction band.
- If station s indicated its currently held option as its preferred option during the bidding round, set $b_{t+1,s} := b_{t,s}$, and set the station's new current price according to the price offer for that option,

i.e., $\hat{P}_{t+1,s} := P_{t,s,b_{t+1,s}}$. If the station indicated that its preferred option is to drop out of bidding, set $b_{t+1,s}$ to be the station's pre-auction band and $\hat{P}_{t+1,s} := 0$.

- If the station's preferred option is neither its currently held option nor to drop out of the auction, check the feasibility of station s in its preferred option given the current tentative assignment. If the station is feasible in its preferred option, set $b_{t+1,s}$ to be its preferred option and $\hat{P}_{t+1,s} := P_{t,s,b_{t+1,s}}$. Otherwise, set $b_{t+1,s}$ to be its fallback option and set $\hat{P}_{t+1,s}$ accordingly.
- Remove station s from the queue and start a new processing loop.

After queue processing is finished, all stations left in the queue are infeasible in their pre-auction bands. For all stations left in the queue, and for all stations that were not placed in the queue due to being frozen at the beginning of this round (*i.e.*, either infeasible in their pre-auction bands, pending catch up or provisionally winning), their currently held option and current price is set to be unchanged for the next round: $b_{t+1,s} := b_{t,s}$ and $\hat{P}_{t+1,s} := \hat{P}_{t,s}$.

5.3 Bid Status Updating

Every station that was left in the queue after the queue processing described in Section 5.2 is infeasible in its pre-auction band, and thus currently frozen. For every other active station, the system checks whether the station is feasible in its pre-auction band.

Then, for every station that is infeasible in its pre-auction band and was not provisionally winning before bid processing, the system checks whether the station has become provisionally winning using the algorithm of Section 5.4. If the station has become provisionally winning, its currently held option and current price become its provisionally winning option and provisionally winning price, respectively. Finally, for every active station that is feasible in its pre-auction band, the system checks whether the station can ever become infeasible (using the algorithm of Section 5.5), and if not, assigns the station a status of "exited - not needed".

If a station is neither "exited" nor "provisionally winning," its status is set as follows:

- If the auction is not in catch-up phase (see Section 7) and the station is feasible in its pre-auction band, the station's status is set to "bidding";
- If the auction is not in catch-up phase and the station is not feasible in its pre-auction band, the station's status is set to "frozen – currently infeasible";
- If the auction is in catch-up phase and the station's catch-up point is less than or equal to the base clock price of the following round, the station's status is set to "frozen – pending catch up";
- If the auction is in catch-up phase and the station is "caught up" (that is, its catch-up point is strictly greater than the base clock price of the following round):
 - o If the station is currently feasible in its pre-auction band, its status is set to "bidding";
 - o If the station is not feasible in its pre-auction band, its status is set to "frozen – currently infeasible".

5.4 Determining Whether a Station is "Frozen – Provisionally Winning"

A station s is assigned a status of "frozen – provisionally winning" once the auction system has determined that it cannot assign the station to its pre-auction band for the remainder of the stage. The auction system determines that a UHF station is a provisional winner when the feasibility checker either proves that the station is infeasible to add to the UHF TV band or when it decides that it cannot prove feasibility in the allotted time for processing that station.

The auction system determines that a VHF station is a provisional winner when this station is proven to be infeasible to add to its pre-auction band in that stage for any possible bidding behavior of stations that

are still active in the auction. This is described in more detail below, depending on the pre-auction band of the VHF station.

For the purposes of this section, a station is considered *inactive* if either it did not participate in the auction or its status is “exited – voluntary” or “exited – not needed.” Thus, every inactive station must be assigned a channel in its pre-auction band.

A High-VHF station s is provisionally winning if the auction system determines that it is not possible to satisfy all of the following:

- Assign station s to a channel in High-VHF;
- Assign every inactive High-VHF station to a channel in High-VHF;
- Assign every provisionally winning UHF station whose currently held option is High-VHF to a channel in High-VHF;
- Assign each of the above stations to one of its allowable channels in High-VHF, as defined in the *domain.csv* file; and
- Do not violate any adjacent and co-channel pairwise interference restrictions as defined in the *interference_paired.csv* file.

A Low-VHF station s is provisionally winning if the auction system determines that it is not possible to satisfy all interference constraints and achieve all of the following:

- Assign station s to a channel in Low-VHF;
- Assign every inactive Low-VHF station to a channel in Low-VHF;
- Assign every provisionally winning UHF and High-VHF station whose currently held option is Low-VHF to a channel in Low-VHF;
- Assign each of the above stations to one of its allowable channels in Low-VHF, as defined in the *domain.csv* file; and
- Do not violate any adjacent and co-channel pairwise interference restrictions as defined in the *interference_paired.csv* file.

5.5 Determining Whether a Station is “Exited – Not Needed”

A station s is assigned a status of “exited – not needed” if it is determined that the station would remain feasible in its pre-auction band for any possible bidding behavior of stations that are still active in the auction. When this is determined, the station is notified that it will be assigned to its pre-auction band and will no longer participate in the auction.

The following algorithm is used during processing to determine whether station s with pre-auction band b should be assigned a status of “exited - not needed:”

- First, determine the set of stations (other than station s) that could end up in band b ; denote this set by X . A station $u \neq s$ is included in X if and only if one of the following two conditions holds:
 - (1) The currently held option of station u is band b ,¹⁰ or
 - (2) The following three conditions all hold:
 - The currently held option of station u is below b ; and
 - u is not provisionally winning; and

¹⁰ Note that the currently held option of an exited station is its pre-auction band. Moreover, the currently held option of a non-participating station is also its pre-auction band.

- b is permissible for station u (see Section 3.1 for the definition of “permissible”) and the station indicated it is willing to consider that option on its application.
- For each pair of stations (s, u) and channel c , let A_{su}^c be a count of the number of applicable interference constraints. In particular, A_{su}^c is the number of applicable interference constraints limiting the assignment of station u to a channel in $\{c - 2, c - 1, c, c + 1, c + 2\}$ when station s is placed in channel c , taking into account the domains of stations s and u .¹¹ Thus, A_{su}^c represents the number of channels that are ruled out for station u if station s is placed in channel c . This is a number between 0 and 5. Each A_{su}^c is determined at the beginning of the auction and remains unchanged throughout the auction.
- For every station $u \in X$, let $f(u)$ be the maximum number of channels that s might rule out for s in band b . In particular, set $f(u)$ to be the maximum value of A_{su}^c among all channels c in band b . This is a number between 0 and 5, depending on the interference constraints.
- If $\sum_{u \in X} f(u)$ is less than the number of channels that station s has available in band b (that is, the domain of s restricted to b), then station s is deemed “exited - not needed.”

Example 1:

Suppose that:

- (i) channel c is in the domain of station s ;
- (ii) channels $\{c - 2, c - 1, c, c + 1, c + 2\}$ are all in the domain of station u ; and
- (iii) if station s is placed in channel c , then station u cannot be placed in any of the following channels: $\{c - 2, c - 1, c, c + 1, c + 2\}$.

Then $A_{su}^c = 5$, since placing station s in channel c will preclude u from being placed in 5 channels.

Example 2:

Suppose that:

- (i) channel c is in the domain of station s ;
- (ii) channels $\{c - 2, c - 1, c, c + 1, c + 2\}$ are all in the domain of station u ; and
- (iii) if station s is placed in channel c , then station u cannot be placed in channel c but could be placed in channels $\{c - 2, c - 1, c + 1, c + 2\}$.

Then $A_{su}^c = 1$, since placing station s in channel c will preclude u from being placed in 1 channel.

Example 3:

Suppose that:

- (i) channel c is in the domain of station s ;
- (ii) channels $\{c - 2, c - 1, c\}$ are in the domain of station t , whereas channels $\{c + 1, c + 2\}$ are not; and
- (iii) if station s is placed in channel c , then station t cannot be placed in channel c or channel $c - 1$ but could be placed in channel $c - 2$.

Then $A_{su}^c = 2$. In particular, out of three possible placements for u , placing s in channel c will preclude u from being placed in two of them: c and $c - 1$.

Example 4:

Suppose that channel c is not in the domain of station s . Then $A_{su}^c = 0$.

Each A_{su}^c is determined at the beginning of the auction and remains unchanged throughout the auction.

¹¹ The need for looking at second adjacent constraints (c-2 and c+2) is a result of the *Canadian Coordination* which requires second adjacent constraints be considered for a small subset of Canadian stations.

6 Information Policy

6.1 Vacancy Index

The vacancy index for station s , band b in round t , denoted as $I_{t,s,b}$, is defined as:

$$I_{t,s,b} = V_{t,s,b} \cdot M_b$$

where $V_{t,s,b}$ is equal to the corresponding vacancy (as defined in Section 3.3) and M_b denotes the number of channels in band b .

The minimum possible value of the vacancy index is 0.5, because the parameter VAC_FLOOR is set to 0.5 (see Section 3.3). The maximum possible value is the number of channels in band b .

Stations are not informed about the precise value of their vacancy index, but they are given information about the range of their current vacancy index. Specifically, each station will be shown a vacancy index range for its pre-auction band and for bidding options that are above the station's currently held option, as described in Sections 6.2 and 6.3 respectively.

All calculations that are required for reporting vacancy index ranges are done after the bidding round is processed. Therefore, these calculations are based on the same vacancy information that is used to set up the next round and calculate the new price offers.

6.2 Information about the Pre-auction Band

6.2.1 UHF station

Each active UHF station is informed about which of the following ranges its current vacancy index for the UHF band belongs:

- i. $[0.5, 3)$
- ii. $[3, 6]$
- iii. $(6, M_{UHF}]$

where M_{UHF} denotes the number of channels in the UHF band available for TV stations. The number of channels in the UHF band available for TV stations is determined by the current clearing target, and is larger in later stages of the auction.

6.2.2 High-VHF station

Each active High-VHF station is informed about which of the following ranges its current vacancy index for the High-VHF band belongs:

- i. $[0.5, 2)$
- ii. $[2, 4]$
- iii. $(4, M_{HV}]$

where M_{HV} denotes the number of channels in the High-VHF band. Note that the number of channels in the High-VHF band is 7 (*i.e.*, $M_{HV} = 7$) in every stage.

6.2.3 Low-VHF station

Each active Low-VHF station is informed about which of the following ranges its current vacancy index for the Low-VHF band belongs:

- i. $[0.5, 2)$
- ii. $[2, 4]$

iii. $(4, M_{LV}]$

where M_{LV} denotes the number of channels in the Low-VHF band. Note that the number of channels in the Low-VHF band is 5 (*i.e.*, $M_{LV} = 5$) in every stage.

6.3 Information about Other Bands

Each station s will be given a vacancy index range for each bidding option that is above the station's currently held option and for which the bidder indicated it was willing to consider in its application. For example, if the currently held option of a UHF station is to go off-air and the bidder selected both VHF options in its application for that station, the station will be given a vacancy index range for each VHF band. At the same time, if the currently held option of a UHF station is to move to High-VHF, the station will not be provided with any vacancy information for the VHF bands (it will still get a vacancy range for the UHF band).

The information shown to station s is the information implied by its reduction coefficients $r_{t,s,HV}$ and $r_{t,s,LV}$ that are used to calculate benchmark prices in round t (see formulas in Section 3.4).

6.3.1 High-VHF band

The implied vacancy index range for the High-VHF band is calculated using the following formula:

$$I_{t,s,HV} = \frac{M_{HV}}{M_{UHF}} \left[\frac{p_{0,HV}}{p_{0,OFF} - p_{0,HV}} \cdot \frac{1 - r_{t,s,HV}}{r_{t,s,HV}} \right]^2 \cdot I_{t,s,UHF}$$

and by substituting $I_{t,s,UHF}$ with the endpoints of the UHF vacancy index range shown to the station (described in Section 6.2.1) in order to get the minimum and maximum implied values for the vacancy index in the High-VHF band.

If needed, the resulting interval is bounded so that it is contained in the actual $[0.5, M_{HV}]$ interval for the vacancy index of the High-VHF band. Bidders will see the implied vacancy index range with the endpoints of the interval rounded to one decimal place (the minimum value is rounded down and the maximum value is rounded up).

6.3.2 Low-VHF band

An implied vacancy index for the Low-VHF band might be needed for both UHF stations and High-VHF stations (provided that the station's currently held option is to go off-air).

The implied vacancy index for the Low-VHF band is calculated using the following formula:

$$I_{t,s,LV} = \frac{M_{LV}}{M_{HV}} \left[\frac{p_{0,LV} - p_{0,HV}}{p_{0,OFF} - p_{0,LV}} \cdot \frac{1 - r_{t,s,LV}}{r_{t,s,LV} - r_{t,s,HV}} \right]^2 \cdot I_{t,s,HV}$$

and by substituting $I_{t,s,HV}$ with the endpoints of the High-VHF vacancy index range shown to the station (described in Section 6.2.1 for a UHF station and in Section 6.2.2 for a High-VHF station) in order to get the minimum and maximum implied values for the vacancy index in the Low-VHF band.

If needed, the resulting interval is bounded so that it is contained in the actual $[0.5, M_{LV}]$ interval for the vacancy index of the Low-VHF band. Bidders will see the implied vacancy index range with the endpoints of the interval rounded to one decimal place (the minimum value is rounded down and the maximum value is rounded up).

7 Transition to a New Stage

If stage $u - 1$ fails to satisfy the final stage rule, the incentive auction will proceed with stage u . Stage u will have a lower clearing target than stage $u - 1$. Because of the reduced clearing target of stage u , some of the stations that were provisional winners at the end of stage $u - 1$ may become active at the beginning of stage u .

In the beginning of a new stage, the auction system will re-evaluate the bidding status of each station that was provisionally winning in the prior stage of the reverse auction in light of the reduced clearing target. The auction system will then inform newly-active stations that they will be returned to the active status of “bidding,” “frozen – currently infeasible,” or “frozen – pending catch up,” whichever the case may be. As long as at least one station has the status of “frozen – pending catch up” the auction is considered to be in *catch-up phase*.

The auction system will reset the base clock price to the highest *catch-up point* of all newly-active stations. For each newly-active station, its *catch-up point* is the lowest base clock price at which that station became provisionally winning in a previous stage.

The base clock price will descend from the reset price (i.e., the highest catch-up point of newly-active stations). Bidders with a newly-active station that is “frozen – pending catch up” will not resume bidding in the current round until the base clock price falls below the station’s catch up point and its status changes. Once the base clock price descends to that point, such bidders will see their station’s bidding status change to “bidding” if the station has a feasible channel assignment, or “frozen – currently infeasible” if the station is a VHF station and does not currently have a feasible channel assignment. Any stations that exited in a prior stage will retain that status and will not resume bidding.

The price reduction and bidding in every stage proceed as in the first stage. However, the benchmark prices of a station are not reduced and the station is not asked to bid, as long as the station’s status is “frozen – pending catch up.”

For every station s that was provisionally winning at the end of stage $u - 1$:

- Let w_s denote its provisionally winning price at the end of stage $u - 1$.
- Let $q_{s,b}$ denote the benchmark price of station s for option b in the round the station became provisionally winning for the last time.

Thus, $q_{s,OFF}$ represents the base clock price of the round that station s became provisionally winning for the last time. In other words, $q_{s,OFF}$ is the catch-up point of station s , i.e., the lowest base clock price at which station s became provisionally winning in a previous stage.

If station s was provisionally winning throughout stage $u - 1$, then $q_{s,b}$ is the benchmark price for b from the last round in the most recent stage in which the station became provisionally winning before stage $u - 1$. If station s was provisionally winning throughout stages $1, 2, \dots, u - 1$, then $q_{s,b}$ is the opening benchmark price for b .

7.1 Currently Held Option and Current Price

At the beginning of a new stage, the auction system initializes the currently held option and current price for each station as described below.

For each station that was “frozen – provisionally winning” at the end of the previous stage but has become “exited – not needed,” its currently held option is set to the station’s pre-auction band and its current price is set to 0.

For every other station, the auction system initializes its currently held option to be equal to what it was at the end of the previous stage. If station s was “frozen – provisionally winning” at the end of the previous stage, its current price at the beginning of the new stage is set to w_s .

7.2 Newly-active Stations

At the beginning of stage $u > 1$, the auction system checks which of the stations that were “frozen – provisionally winning” at the end of stage $u - 1$ remain “frozen – provisionally winning” for the clearing target of stage u . A station that was “frozen – provisionally winning” at the end of stage $u - 1$ but is neither “frozen – provisionally winning” nor “exited – not needed” at the beginning of stage u is labelled as “newly active.” Let N_0 denote the set of “newly active” stations at the beginning of stage u .

7.3 Base Clock Price

Let c_t denote the base clock price in round t of stage u . For the new stage, the auction system initializes the base clock price to be equal to the maximum of $q_{s,OFF}$ among all newly active stations. This initial value is denoted by c_0 . That is, $c_0 := \max_{s \in N_0} \{q_{s,OFF}\}$

7.4 Benchmark Prices

The benchmark price of a newly active station s for option b (where $b \in \{OFF, LV, HV\}$) is initialized to be equal to $q_{s,b}$.

7.5 Bidding Statuses for Active Stations

- If the base clock price of round t is greater than or equal to the catch-up point of station s (that is, $c_t \geq q_{s,OFF}$) and station s is active (i.e., the station is neither exited nor provisionally winning), then the bidding status of the station is “frozen – pending catch up.” Let N_t denote the set of stations with status “frozen – pending catch up” in round t . That is, $N_t = \{s: s \text{ Active and } c_t \geq q_{s,OFF}\}$.
- If the base clock price of round t is strictly smaller than the catch-up point of station s (that is, $c_t < q_{s,OFF}$) and station s is feasible in its pre-auction band, then the bidding status of the station is “bidding.”
- If the base clock price of round t is strictly smaller than the catch-up point of station s (that is, $c_t < q_{s,OFF}$) and station s is a VHF station that is infeasible in its pre-auction band, then the bidding status of the station is “frozen – currently infeasible.”

7.6 Price Decrement

The price decrement is calculated as:

$$d_t := \max\{R_1 \cdot c_{t-1}, R_2 \cdot p_{0,OFF}\}$$

The auction system will use the current values of the parameters R_1 and R_2 to set the decrement unless that decrement would result in an *empty round*, i.e., a round in which no station has the status “bidding.” As noted in Section 3, R_1 and R_2 have default values $R_1 = 5\%$ and $R_2 = 1\%$.

7.7 Avoiding Empty Rounds

If setting the decrement using the current values of R_1 and R_2 would result in an empty round (i.e., there would be no bidding stations in the round, since all the stations that are feasible in their pre-auction bands would be pending catch-up), the auction system calculates the threshold \bar{R}_1 as the smallest integer multiple of 1% that is strictly larger than:

$$\hat{R}_1 := \frac{c_{t-1} - \max_{s \in A} \{q_{s,OFF}\}}{c_{t-1}}$$

where A denotes the set of all active stations that are feasible in their pre-auction bands. That is,

- If \hat{R}_1 can be written with no more than two digits after the decimal point, set $\bar{R}_1 = \hat{R}_1 + 0.01$;
- Otherwise, round the number up (so that the rounded number has at most two digits after the decimal point) and set \bar{R}_1 to be equal to the rounded number.

For example, if:

$$\frac{c_{t-1} - \max_{s \in A} \{q_{s,OFF}\}}{c_{t-1}} = 0.12$$

then $\hat{R}_1 = 0.13$ or 13%, and if

$$\frac{c_{t-1} - \max_{s \in A} \{q_{s,OFF}\}}{c_{t-1}} = 0.13172$$

then $\bar{R}_1 = 0.14$ or 14%. The Commission will either set R_1 equal to \bar{R}_1 or choose a larger value for the parameter R_1 . The auction system will then calculate the corresponding price decrement d_t .

7.8 Price Offers, Bidding and Bid Processing Procedures in Catch-up Phase

In each round $t = 1, 2, \dots$ of the catch-up of stage u , the auction system proceeds according to the following algorithm:

- Set the base clock price of round t as follows: $c_t := c_{t-1} - d_t$;
- Identify the set of stations that are “frozen – pending catch up” in round t ; this set is denoted by N_t . Note that $N_t \subseteq N_{t-1}$;
- For every station $s \in N_{t-1} \setminus N_t$ (i.e., a station that was pending catch up in round $t - 1$ and caught up in round t):¹²
 - o Compute the decrement that needs to be applied to station s as: $d_s := q_{s,OFF} - c_t$. Note that $d_s \leq d_t$;
 - o Set the benchmark prices of station s for round t as follows:
 - $p_{t,s,OFF} := q_{s,OFF} - d_s$;
 - $p_{t,s,b} := q_{s,b} - r_{t,s,b} \cdot d_s$, for $b = LV, HV$,
 where $r_{t,s,b}$ denotes the reduction coefficient (see Section 3.4);
 - o Set the price offers of station s for round t as described in Section 3.6;
- The benchmark prices and price offers of stations not in N_{t-1} with statuses “bidding” and “frozen – currently infeasible”¹³ are set as described in Sections 3.5 and 3.6;
- The benchmark prices of stations with status “frozen – pending catch up” are not updated;
- **Bidding:** Any station that is “frozen – pending catch up” or “frozen – currently infeasible” is not asked to bid, but is allowed to submit proxy bid instructions. All stations with the status “bidding” are asked to bid;
- **Bid Processing:** Bids are processed as described in Section 5.2.

The catch-up phase of stage u ends when there are no stations with status “frozen – pending catch up.” This occurs when $q_{s,OFF} > c_t$ for all active stations s .

¹² $N_{t-1} \setminus N_t$ denotes all elements of the set N_{t-1} that are not in N_t .

¹³ Such stations were caught up before round t .

It could be that station s becomes provisionally winning before the base clock price c_t drops below the station's catch-up point. In that case, if the auction proceeds to a subsequent stage and station s is newly-active in that stage, its benchmark prices $q_{s,b}$ carry over to the next stage.

A similar logic applies to a station's provisionally winning price. If in the new stage a station becomes "frozen – pending catch up" and then becomes "provisionally winning" without bidding to accept a lower price offer, it will continue to be provisionally winning at the price it already accepted.

For example, consider a UHF station s with volume equal to 1 whose currently held option is off-air. Suppose that the station's provisionally winning price from stage $u - 1$ is \$50 (that is, the station became provisionally winning when the base clock price was \$50) and in stage u station s becomes provisionally winning when the base clock price is \$100. The station's provisionally winning price for stage u will be set to \$50, *i.e.*, the station's provisionally winning price will not change from the previous stage.

Example:

Suppose that the opening base clock price is 2,000, and $R_1 = 0.05$ and $R_2 = 0.01$ throughout stage 1 and stage 2. For the purposes of this example, we assume that the base clock price is rounded to the nearest integer.

When stage 2 of the reverse auction starts, there are five newly active stations: s_1 , s_2 , s_3 , s_4 , and s_5 . That is, stations $s_1 - s_5$ were provisionally winning at the end of stage 1, and active at the beginning of stage 2. The following table gives the stations' catch-up points, *i.e.*, the benchmark price to go off-air from the last round at which each of these stations became provisionally winning ($q_{s,OFF}$):

Station	Catch-up point ($q_{s,OFF}$)
s_1	976
s_2	976
s_3	881
s_4	755
s_5	755

At the beginning of stage 2 the base clock price is initialized to $c_0 = 976$. Thus, the base clock price for round 1 of stage 2 is:

$$c_1 = 976 - \max\{0.05 \cdot 976, 0.01 \cdot 2000\} = 927$$

and both stations s_1 and s_2 become "bidding" and are asked to bid in the round. Stations s_3 , s_4 , and s_5 are "frozen – pending catch up" and are not asked to bid because the base clock price is still too high. The following table shows how the stations' statuses change in each round assuming that all stations are feasible in their pre-auction bands.

Round (t)	Base clock price (c_t)	Bidding	Frozen - Pending Catch Up
1	927	s_1, s_2	s_3, s_4, s_5
2	881	s_1, s_2	s_3, s_4, s_5
3	837	s_1, s_2, s_3	s_4, s_5
4	795	s_1, s_2, s_3	s_4, s_5
5	755	s_1, s_2, s_3	s_4, s_5
6	717	s_1, s_2, s_3, s_4, s_5	-

The catch-up phase of stage 2 ends after round 6.

8 Illustrative Example

The following simple example illustrates the mechanics of the price offer calculation and the bid processing algorithm. For expository ease, the example involves the first stage of the auction and corresponds to a hypothetical world in which each band has just one channel.

There are two locations: A and B. Stations 1, 2, and 3 are in location A. Stations 4, 5, and 6 are in location B. The pre-auction band of all six stations is UHF. The volume of each of these stations is equal to 1.

Assume that there is one channel available in Low-VHF in location A, and one in location B. That is, if one of the stations in location A is in Low-VHF, no other station in location A can be assigned there. Make the same assumption for the High-VHF band.

Further assume that there is only one available channel in UHF to serve both locations. That is, if one of the six stations is assigned in UHF, then no other station can be assigned there.

The opening prices are: \$900 to go off-air, \$675 to move to Low-VHF and \$360 to move to High-VHF. In the application process, every station selects going off-air as its preferred option.

For the purposes of this example, assume that the decrement parameters are $R_1 = 5\%$ and $R_2 = 1\%$. Also, we assume that $VAC_FLOOR = 0.1$.¹⁴ In all calculations, prices are rounded to the nearest integer.

8.1 Round 1

8.1.1 Price offer Calculation

In the initial assignment, the currently held option of every station is to go off-air. For round 1, the vacancies are $V_{1,s,b} = 1$ for all stations s and all bands b . This implies that the reduction coefficients are: $r_{1,s,HV} = 0.4$ and $r_{1,s,LV} = 0.75$ for all stations s . After computing the benchmark prices for round 1, we conclude that the price offers are: $P_{1,s,OFF} = \$855$, $P_{1,s,LV} = \$641$, and $P_{1,s,HV} = \$342$ for all stations s .¹⁵

8.1.2 Bidding

Assume that in round 1, every station selects going off-air as its preferred option at the price offers.

8.1.3 Bid Processing

The stations are placed in the queue in a pseudorandom order. The result of bid processing is that $b_{2,s} = OFF$ and $\hat{P}_{2,s} = \$855$ for all stations s . That is, for every station the currently held option is to go off-air and the current price is \$855.

¹⁴ Set $VAC_FLOOR = 0.1$ for the purposes of this simple example where each band has a very small number of channels. The auction system will set $VAC_FLOOR = 0.5$.

¹⁵ In this example, the price offers are equal to the corresponding benchmark prices, because the volume of every station is equal to 1 and UHF is the pre-auction band of every station.

This is illustrated in Figure 4 below:



	Location A	Location B
Remain in UHF	$p_{1,UHF}$ \$0	$p_{1,UHF}$ \$0
Move to High-VHF	$p_{1,HV}$ \$342	$p_{1,HV}$ \$342
Move to Low-VHF	$p_{1,LV}$ \$641	$p_{1,LV}$ \$641
Go Off-air	$p_{1,OFF}$ \$855	$p_{1,OFF}$ \$855
		

Figure 4: Round 1 benchmark prices and currently held options after bid processing

8.2 Round 2

8.2.1 Price offer Calculation

Since the currently held option of all stations is to go off-air, the vacancies are $V_{2,s,b} = 1$ for all stations s and all bands b . This implies that the reduction coefficients are: $r_{2,s,HV} = 0.4$ and $r_{2,s,LV} = 0.75$ for all stations s . After computing the benchmark prices for round 2, the price offers are: $P_{2,s,OFF} = \$812$, $P_{2,s,LV} = \$609$, and $P_{2,s,HV} = \$325$ for all stations s .

8.2.2 Bidding

Assume that in round 2, station 1 selects to move to Low-VHF as its preferred option and to go off-air as its fallback option. Every other station selects to go off-air as its preferred option.

8.2.3 Bid Processing

The stations are placed in the queue in a pseudorandom order. The result of bid processing is that $b_{3,1} = LV$, $\hat{P}_{3,1} = \$609$; and $b_{3,s} = OFF$ and $\hat{P}_{3,s} = \$812$ for stations $s \in \{2,3,4,5,6\}$.

This is illustrated in Figure 5 below:

	Location A	Location B
Remain in UHF	$P_{2,UHF}$ \$0	$P_{2,UHF}$ \$0
Move to High-VHF	$P_{2,HV}$ \$325	$P_{2,HV}$ \$325
Move to Low-VHF	$P_{2,LV}$ \$609	$P_{2,LV}$ \$609
Go Off-air	$P_{2,OFF}$ \$812	$P_{2,OFF}$ \$812

Figure 5: Round 2 benchmark prices and currently held options after bid processing

8.3 Round 3

8.3.1 Price offer Calculation

In location A, the currently held option of one of the stations (station 1) is Low-VHF and the currently held option of the other two stations is to go off-air. In location B, the currently held options of all stations is to go off-air. The vacancies are $V_{3,s,b} = 1$ for all stations s and bands $b \in \{HV, UHF\}$. Moreover, $V_{3,s,LV} = 0.1$ for $s \in \{1,2,3\}$ and $V_{3,s,LV} = 1$ for $s \in \{4,5,6\}$. That is, in location A the vacancy in Low-VHF is smaller than in location B, because a station is currently assigned in Low-VHF in location A. This implies that the reduction coefficients are: $r_{3,s,HV} = 0.4$ for all stations s ; and $r_{3,s,LV} = 0.8894$ for $s \in \{1,2,3\}$ and $r_{3,s,LV} = 0.75$ for $s \in \{4,5,6\}$. After computing the benchmark prices for round 3, the price offers are: $P_{3,s,OFF} = \$771$, and $P_{3,s,HV} = \$309$ for all stations s . Moreover, $P_{3,s,LV} = \$573$ for $s \in \{1,2,3\}$ and $P_{3,s,LV} = \$579$ for $s \in \{4,5,6\}$.

8.3.2 Bidding

Assume that in round 3,

- Station 1 selects to move to Low-VHF as its preferred option.
- Station 2 selects to move to High-VHF as its preferred option, and to drop out as its fallback option.
- Station 3 selects to move to High-VHF as its preferred option, and to drop out as its fallback option.
- Station 4 selects to move to Low-VHF as its preferred option, and to drop out as its fallback option.
- Station 5 selects to drop out as its preferred option.
- Station 6 selects to go off-air as its preferred option.

8.3.3 Bid Processing

First, the bid processing algorithm gives the lowest priority to station 1 (since $\hat{P}_{3,1} - P_{3,1,b_{3,1}} < \hat{P}_{3,s} - P_{3,s,b_{3,s}}$ for every $s \in \{2,3,4,5,6\}$) and then considers the bids of stations 2–6 in a pseudo-random order.¹⁶ Suppose that the ordering is: 4, 2, 3, 5, 6, 1.

Station 4 is considered first: the station's currently held option is set to Low-VHF, and its current price is set equal to the price offer of that option. Then, station 2 is considered and is switched to High-VHF. Station 3 is considered next: station 3 cannot be added to its preferred option (*i.e.*, High-VHF) because station 2 is already there. Thus, station 3 drops out of the auction (its fallback option).

Now that station 3 is in UHF, all the other stations are infeasible in their pre-auction bands and become provisionally winning. This stage of the reverse auction ends because there are no active stations.

8.3.4 Outcome

At this point, the status of station 3 is “exited – voluntary” (because it has dropped out of the auction) and all other stations are provisionally winning. The provisionally winning assignments are: Low-VHF for station 1, High-VHF for station 2, Low-VHF for station 4, and off-air for stations 5 and 6. The provisionally winning prices are \$609 for station 1, \$309 for station 2, \$579 for station 4, and \$812 for stations 5 and 6. If this is the final stage of the auction, these will become the winning assignments and prices.

¹⁶ See Section 5.2 for how bids are ordered during bid processing.

This is illustrated in

	Location A	Location B
Remain in UHF	$P_{3,UHF}$ \$0	$P_{3,UHF}$ \$0
Move to High-VHF	$P_{3,HV}$ \$309	$P_{3,HV}$ \$309
Move to Low-VHF	$P_{3,LV}$ \$573	$P_{3,LV}$ \$579
Go Off-air	$P_{3,OFF}$ \$771	$P_{3,OFF}$ \$771

Figure 6 below:

	Location A	Location B
Remain in UHF	$P_{3,UHF}$ \$0	$P_{3,UHF}$ \$0
Move to High-VHF	$P_{3,HV}$ \$309	$P_{3,HV}$ \$309
Move to Low-VHF	$P_{3,LV}$ \$573	$P_{3,LV}$ \$579
Go Off-air	$P_{3,OFF}$ \$771	$P_{3,OFF}$ \$771

Figure 6: Round 3 benchmark prices and currently held options after bid processing

The following tables show the benchmark prices that are updated for each round.

For stations in Location A:

t	$p_{t,s,OFF}$	$p_{t,s,LV}$	$p_{t,s,HV}$
0	\$900	\$675	\$360
1	\$855	\$641	\$342
2	\$812	\$609	\$325
3	\$771	\$573	\$309

For stations in Location B:

t	$p_{t,s,OFF}$	$p_{t,s,LV}$	$p_{t,s,HV}$
0	\$900	\$675	\$360
1	\$855	\$641	\$342
2	\$812	\$609	\$325
3	\$771	\$579	\$309

APPENDIX E

Final Channel Assignment Optimization

1 Introduction

This technical appendix provides a final version of Appendix E of the *Auction 1000 Comment PN* describing the procedure for determining a final assignment of television stations to channels in the remaining television bands, pursuant to the Commission's decision in the *Auction 1000 Bidding Procedures PN*.¹ Once the final stage rule has been met, no further stages of the incentive auction will be conducted, so it will be possible to finalize channel assignments to those stations that will remain in broadcasting. The final channel assignment procedures will assign non-participating stations, stations that dropped out of the bidding, and those that the auction system determined were not needed to channels in their pre-auction bands. Provisionally winning stations that were assigned to move to a VHF band will be assigned a channel in the appropriate VHF band. The final channel assignment procedure will not, however, modify any assignments of UHF stations to channels in the 600 MHz Band that were determined during the clearing target determination procedure for the final stage of the auction as adopted by the Commission in the *Auction 1000 Procedures PN*. Hence, the final channel assignment procedure will not change impairments to forward auction licenses.

The final channel assignment optimization procedure will employ mathematical optimization techniques to determine a final channel assignment considering four objectives. These are, in order of priority: (1) maximize the number of channel "stays," or stations assigned to their pre-auction channel rather than being assigned to a new channel; (2) minimize aggregate new interference; (3) avoid reassignment of stations with high anticipated relocation costs in order to minimize total relocation costs; and (4) prioritize assignments to Low-VHF channel 5 and avoid assignments to UHF channel 14. The resulting objective value of each optimization will become a constraint on the next optimization problem to be solved.

This appendix first defines the concept of a feasible assignment of TV stations in the context of the final channel assignment optimization, and then continues with a detailed discussion of the optimization process and mathematical formulations for each problem. Pursuant to the FCC's arrangement with Industry Canada (IC) for repurposing TV spectrum,² the final channel assignment will assign channels to stations in both the U.S. and in Canada. Feasibility requirements ensure that any assignment satisfies all interference constraints among stations within and among stations in the U.S., Canada and Mexico.³

¹ See *Broadcast Incentive Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, GN Docket No. 12-268, AU Docket No. 14-252, 30 FCC Rcd 8975, 9100-05, para. 271-81 (2015) (*Auction 1000 Bidding Procedures PN*).

² *Statement of Intent Between the Federal Communications Commission of the United States of America and the Department of Industry Canada Related to the Reconfiguration of Spectrum Use in the UHF Band for Over-the-Air Television Broadcasting and Mobile Broadband Services*, U.S.-Can., Aug. 11, 2015, available at <https://transition.fcc.gov/ib/sand/agree/files/PASIIIC.pdf> (Canadian Coordination).

³ See *id.*; see also *Exchange of Coordination Letters with IFT Regarding DTV Transition and Reconfiguration of 600 MHz Band Spectrum*, U.S.-Mex., July 15, 2015, available at <http://wireless.fcc.gov/incentiveauctions/learn-program/resources.html> (Mexican Coordination).

2 Feasible Assignments

After the final stage rule has been met, the final channel assignment optimization will determine an assignment of TV stations that meets the following conditions:

- (1) All stations are given an assignment to a channel in the same band as that provisionally assigned to them in the final round of the final stage of the reverse auction.
- (2) Each station is assigned to one of its allowable channels, as defined in the *domain.csv* file.
- (3) Station-channel assignments must not violate adjacent and co-channel pairwise interference restrictions as defined in the *interference_paired.csv* file.
- (4) Stations assigned to the 600 MHz Band remain on the same channel assigned during the last stage of the auction.

An assignment of stations that meets all of the above conditions is considered feasible. All solutions to the final channel assignment optimization must be feasible. The linear constraints that enforce conditions (1) through (4) are provided below.

Set Definitions:

S is the set of all stations in both the U.S. and Canada remaining on air at the conclusion of the auction.

C_s is the set of allowable channels for U.S. station s in the band in which s was provisionally assigned at the end of the reverse auction. For a Canadian station, it is the set of allowable channels in its pre-auction band.

For a station assigned to a channel in the 600 MHz Band, C_s consists of only the channel to which the station was assigned during the process of setting the clearing target for the last stage of the auction. For UHF stations assigned to a channel in the remaining TV band, C_s consists of only allowable UHF channels within the remaining TV band.

Variable Definitions:

$x_{s,c}$ is a binary decision variable which has a value of 1 if station s is assigned to channel c and 0 otherwise.

Feasibility Constraints:

$$\sum_{c \in C_s} x_{s,c} = 1 \quad \forall s \in S \quad (1)$$

$$x_{s,c} + x_{s',c} \leq 1 \quad \forall \{(s,c), (s',c)\} \in CoPairs \quad (2)$$

$$x_{s,c} + x_{s',c'} \leq 1 \quad \forall \{(s,c), (s',c')\} \in AdjPairs \quad (3)$$

$$x_{(s,c)} \in \{0,1\} \quad \forall s \in S, \forall c \in C_s \quad (4)$$

Explanation of Constraints:

1. Each station must be assigned.

$$\sum_{c \in C_s} x_{s,c} = 1 \quad \forall s \in S$$

The set C_s is the set of allowable channels for station s in the band where s was assigned. This constraint ensures that every station is assigned to exactly one channel from that set.

2. Station assignments must adhere to the co-channel interference restrictions.

$$x_{s,c} + x_{s',c} \leq 1 \quad \forall \{(s,c), (s',c)\} \in CoPairs$$

For every pairwise restriction that precludes two stations from occupying the same channel, a constraint is created that indicates that at most one of the two stations (s and s') can be assigned to that channel c . The set includes all station pairs that cannot occupy the same channel.

3. Station assignments must adhere to the adjacent channel restrictions.

$$x_{s,c} + x_{s',c'} \leq 1 \quad \forall \{(s,c), (s',c')\} \in AdjPairs$$

Similarly, for every two station-channel pairs (s,c) and (s',c') where channels c and c' are adjacent and where if station s is on channel c then station s' cannot be on channel c' , a constraint is created that allows only one of these two assignments. That is, the constraints enforce the adjacent channel requirements.

4. The decision variables can only take on the values zero or one.

$$x_{s,c} \in \{0,1\} \quad \forall s \in S, \forall c \in C_s$$

For each allowable station-channel combination, the value of the variable $x_{s,c}$ is restricted to be either 0 or 1; *i.e.*, the station is either assigned to the channel or it is not.

3 Determining the Final Channel Assignment

In the *Auction 1000 Procedures PN*, the Commission established the following sequence of final channel assignment optimization objectives:

- (1) Maximize the number of stations that remain on their pre-auction channel. A separate optimization is solved for each band (UHF, High-VHF and Low-VHF). Since a station can only be assigned to the band it was tentatively assigned at the end of the auction, solving each band separately does not change the solution and allows each optimization to be solved faster.
- (2) Among solutions that keep at least 95 percent of the maximum number of stations found in (1) on their pre-auction channel, minimize the maximum amount of aggregate new interference that any station receives. Since the aggregate interference in the U.S. and in Canada might be quite different, two optimizations are performed. The first minimizes the maximum aggregate interference across all bands and both countries. The second step, then fixes the maximum aggregate interference across countries and minimizes the sum of the maximum aggregate interference of each country.
- (3) Among solutions that satisfy the restrictions of (1) and (2), minimize the costs of relocating stations to new channels in the U.S. and Canada. This optimization enforces all constraints of the first two optimizations and adds constraints that assure that the maximum aggregate interference in each country be no more than that obtained in the second optimization of Step 2.
- (4) Among solutions that satisfy the objectives of (1), (2), and (3), the optimization will choose an assignment that prioritizes assignments of U.S. and Canadian stations to channel 5 in the Low-VHF band and avoids assignments of U.S. and Canadian stations to channel 14.

Step (1) is given highest priority due to its potential to satisfy multiple objectives. Stations that are assigned to their pre-auction channel will not experience terrain loss and will not incur any expense or disruption due to their own relocation.

Step (2) minimizes aggregate new interference subject to the restriction that the number of stations that remain on their pre-auction channel is at least 95 percent of the maximum number found in the first step by band and country, rounded up to the nearest integer. This optimization calculates aggregate interferences as a sum of pairwise interferences and so provides an upper bound on aggregate new interference.

Step (3) finds an assignment that minimizes the total cost of relocating U.S. and Canadian stations to new channels while ensuring that the objectives from the previous two steps are met. It limits the aggregate new interference that any station receives in each country to be no more than the result of the second optimization rounded up to the next one-tenth of one percent.

Finally, Step (4) finds an assignment among all assignments that satisfy the first three steps that prioritizes assignments of stations to channel 5 and avoids assignments of stations to channel 14. In order to assure that the result of Step (3) is enforced, it restricts the total cost of relocation of stations to the result of the third optimization rounded up to the next whole number. Step (4) is designed to search among alternative optimal solutions of Step (3) for solutions that favor assignments of U.S. and Canadian stations to channel 5 and also that avoid assigning U.S. and Canadian stations to channel 14. This step enforces a stricter constraint on the number of stations that must remain on their pre-auction channel. Specifically, the number of keeps must be at least as many as that found in Step (3), rather than 95 percent of the stations that were found in Step (1).

3.1 Step (1): Maximize the number of stations that remain on their pre-auction channel.

In the first step of determining a final channel assignment, the optimization seeks a feasible solution that maximizes the number of stations that remain on their pre-auction channel in the U.S. and in Canada. The optimizations are performed separately for each band. The constraints for this optimization are the same as those defined in Section 2. In addition to the variables and sets defined in that section, a new constant and a subset of S for this optimization are defined below.

Subset:

S_{band} is the set of stations assigned to that band at the close of the reverse auction.

$S_{band,US}$ is the set of U.S. stations assigned to that band at the close of the reverse auction.

$S_{band,CAN}$ is the set of Canadian stations that broadcast in that band prior to the incentive auction.

$S_{band,US}^o$ is the set of U.S. stations in a band whose pre-auction channel is in their assigned band (*i.e.*, this is the set of stations that will stay in their pre-auction band).

Constant:

c_s^o is the pre-auction channel for each station $s \in S_{band,CAN} \cup S_{band,US}^o$

Model Formulation for Step (1):

$$\max Z_{1,band} = \sum_{s \in S_{band,CAN} \cup S_{band,US}^o} x_{s,c_s^o}$$

Subject to:

$$\sum_{c \in C_s} x_{s,c} = 1 \quad \forall s \in S \quad (1)$$

$$x_{s,c} + x_{s',c} \leq 1 \quad \forall \{(s,c), (s',c)\} \in CoPairs \quad (2)$$

$$x_{s,c} + x_{s',c'} \leq 1 \quad \forall \{(s,c), (s',c')\} \in AdjPairs \quad (3)$$

$$x_{(s,c)} \in \{0,1\} \quad \forall s \in S, \forall c \in C_s \quad (4)$$

Explanation of Objective Function:

The objective function maximizes the number $Z_{1,band}$ of stations that are assigned to their pre-auction channel. The value of $Z_{1,band}$ will be an integer greater than or equal to zero. $Z_{1,band} = (Z_{1,band,CAN} + Z_{1,band,US})$, where $Z_{1,band,CAN}$ is the number of Canadian stations that are assigned to their pre-auction channel in that band and $Z_{1,band,US}$ is the number of U.S. stations that are assigned to their pre-auction channel in that band.

3.2 Step (2): Minimize aggregate new interference

Step (2) consists of two parts. Step (2a) minimizes the maximum aggregate new interference that any station receives in a potential assignment. This optimization attempts to push down the upper limit for aggregate new interference for all stations using the pairwise interference percentages as determined by *TVStudy*. Only assignments with pairwise interference between stations of less than 0.5 percent will be considered, as any assignment with interference greater than 0.5 percent is forbidden by the interference restrictions. Relying in this way on pairwise interference introduces potential double counting of interference, meaning that the actual aggregate new interference may be lower than the result of these optimizations.⁴ Since the maximum aggregate interference for the U.S. and Canada might vary, we perform a second optimization that fixes the maximum aggregate interference across both countries, and then minimizes the sum of the maximum aggregate interference of each country.

In Step (2a), new constraints are added to ensure that nearly the same number of stations in the band and country are on their original channels as found in Step (1). In order to provide a little more flexibility in minimizing the amount of aggregate new interference, the constraint will only require that at least 95 percent of the maximum number of stations found in Step (1) for each band and each country, rounded up to the nearest integer, be kept on their original channel. In Step (2b), new constraints are added to enforce the objective value from the optimization in part (2a). The optimization in (2b) ensures that at least the same number of stations in the band and country, or nearly the same, will be on their original channels while seeking to minimize the amount of aggregate new interference that any station receives.

The additional variable, subset and constants for this optimization are defined here.

Variable:

y is the maximum amount of aggregate new interference

Subset:

$SC_{(s,c)}$ is the set of allowable station-channel assignments when station s is assigned to channel c .

Constants:

$pct_{s,c,s',c'}$ is the percent of population facing interference for station s by station s' broadcasting on channel c' if station s broadcasts on channel c .

y_{max} is the maximum amount of possible aggregate new interference for any station including double counting.⁵

$Z'_{1,band,country}$ is 95 percent of the number of stations found in the first optimization for each band for each $country = \{US, CAN\}$, rounded up to the nearest integer⁶.

Model Formulation for Step (2a):

$$\min Z_2 = y$$

⁴ Removing double counting and using actual aggregate new interference would require millions of new variables and tens of millions of new constraints, making the problem intractable.

⁵ To calculate y_{max} , find $\max_{s \in S, c \in C_s} \{ \sum_{(s',c') \in SC_{(s,c)}} pct_{s,c,s',c'} \}$.

⁶ For example, $Z'_{1,band,US} = \lceil .95 * Z_{1,band,US} \rceil$ where the symbol $\lceil \cdot \rceil$ denotes rounding up to the nearest integer.

Subject to:

$$\sum_{c \in C_s} x_{s,c} = 1 \quad \forall s \in S \quad (1)$$

$$x_{s,c} + x_{s',c} \leq 1 \quad \forall \{(s,c), (s',c)\} \in CoPairs \quad (2)$$

$$x_{s,c} + x_{s',c'} \leq 1 \quad \forall \{(s,c), (s',c')\} \in AdjPairs \quad (3)$$

$$x_{(s,c)} \in \{0,1\} \quad \forall s \in S, \forall c \in C_s \quad (4)$$

$$\sum_{s \in S_{band,US}^o} x_{s,c_s^o} \geq Z'_{1,band,US} \quad \forall band \quad (5)$$

$$\sum_{s \in S_{band,CAN}^o} x_{s,c_s^o} \geq Z'_{1,band,CAN} \quad \forall band \quad (6)$$

$$\sum_{(s',c') \in SC_{(s,c)}} pct_{s,c,s',c'} x_{s',c'} \leq y + y_{max}(1 - x_{s,c}) \quad \forall s \in S, c \in C_s \quad (7)$$

$$0 \leq y \leq y_{max} \quad (8)$$

Explanation of Constraints:**1–4: Feasibility Constraints**

Constraints (1) through (4) are the pairwise interference constraints needed for any feasible assignment.

5–6: At least 95 percent of the number of stations found in each band for each country in Step (1) remain on their pre-auction channel.

$$\sum_{s \in S_{band,US}^o} x_{s,c_s^o} \geq Z'_{1,band,US} \quad \forall band$$

$$\sum_{s \in S_{band,CAN}^o} x_{s,c_s^o} \geq Z'_{1,band,CAN} \quad \forall band$$

Constraints (5) and (6) require that at least 95 percent of the same number of stations as found in each band for each country in Step (1) remain on their pre-auction channel.

7: Constraints that calculate the aggregate new interference for a station when that station is assigned to a given channel.

$$\sum_{(s',c') \in SC_{(s,c)}} pct_{s,c,s',c'} x_{s',c'} \leq y + y_{max}(1 - x_{s,c}) \quad \forall s \in S, c \in C_s$$

Constraint (7) determines the aggregate new interference for a station on a specific channel. The left hand side calculates the amount of interference created by interfering station-channels. The right hand side equals y when a station s is assigned to channel c . This means y will take the value of the station with the highest aggregate new interference. If a station is not broadcasting on that channel, the right hand side is $y + y_{max}$. This renders the constraint non-binding, and therefore will not alter the value of y . The highest possible aggregate new interference, y_{max} , can be determined given the remaining stations prior to determining the final channel assignment.

8: Constraints that restrict the value of variable y .

$$0 \leq y \leq y_{max}$$

Constraint (8) requires that y be between 0 and y_{max} .

Explanation of Objective Function:

The objective function minimizes Z_2 , the highest amount of aggregate new interference that any station receives. This objective looks at all stations simultaneously, attempting to find the minimum upper limit of aggregate new interference to a single station. The value of Z_2 will be greater than or equal to 0 and less than or equal to y_{max} .

In order to lower the maximum aggregate interference in the country that did not set the value of Z_2 , a second optimization is performed that minimizes the sum of the maximum aggregate interference in the U.S. and the maximum aggregate interference in Canada with the added constraint that no station can incur more aggregate interference than that found in Step 2a.

Model Formulation for Step (2b):

$$\min Z'_2 = y_{US} + y_{CAN}$$

Subject to:

$$\sum_{c \in C_s} x_{s,c} = 1 \quad \forall s \in S \quad (1)$$

$$x_{s,c} + x_{s',c} \leq 1 \quad \forall \{(s,c), (s',c)\} \in CoPairs \quad (2)$$

$$x_{s,c} + x_{s',c'} \leq 1 \quad \forall \{(s,c), (s',c')\} \in AdjPairs \quad (3)$$

$$x_{(s,c)} \in \{0,1\} \quad \forall s \in S, \forall c \in C_s \quad (4)$$

$$\sum_{s \in S_{band,US}^0} x_{s,c_s^0} \geq Z'_{1,band,US} \quad \forall band \quad (5)$$

$$\sum_{s \in S_{band,CAN}^0} x_{s,c_s^0} \geq Z'_{1,band,CAN} \quad \forall band \quad (6)$$

$$\sum_{(s',c') \in SC_{(s,c)}} pct_{s,c,s',c'} x_{s',c'} \leq y + y_{max}(1 - x_{s,c}) \quad \forall s \in S_{band,CAN}, c \in C_s, \forall band \quad (7)$$

$$\sum_{(s',c') \in SC_{(s,c)}} pct_{s,c,s',c'} x_{s',c'} \leq y_{US} + y_{max}(1 - x_{s,c}) \quad \forall s \in S_{band,US}, c \in C_s, \forall band \quad (8)$$

$$0 \leq y_{US}, y_{CAN} \leq Z_2 \quad (9)$$

Explanation of Constraints:

1–4: Feasibility Constraints

Constraints (1) through (4) are the pairwise interference constraints needed for any feasible assignment.

5–6: At least 95 percent of the number of stations found in each band for each country in Step (1) remain on their pre-auction channel.

Constraint (5) and (6) assure that at least 95 percent of the number of stations found in each country in each band in Step (1) remain at their pre-auction channel.

7-8: These constraints calculate the maximum aggregate interference for each country separately.

$$\sum_{(s',c') \in SC_{(s,c)}} pct_{s,c,s',c'} x_{s',c'} \leq y_{CAN} + y_{max}(1 - x_{s,c}) \quad \forall s \in S_{band,CAN}, c \in C_s, \forall band$$

$$\sum_{(s',c') \in SC_{(s,c)}} pct_{s,c,s',c'} x_{s',c'} \leq y_{US} + y_{max}(1 - x_{s,c}) \quad \forall s \in S_{band,US}, c \in C_s, \forall band$$

Constraints (7) and (8) are new versions of the previous constraint (7) that calculates the maximum aggregate interference for each country separately.

9: This constraint requires that the aggregate interference for each country be no more than that found in Step (2a)

$$0 \leq y_{US}, y_{CAN} \leq Z_2$$

Constraint (9) requires that the maximum aggregate interference in the U.S. and in Canada cannot be greater than the max aggregate interference found in Step (2a).

Explanation of Objective Function:

The objective function minimizes the sum of the maximum aggregate interference incurred by stations in the U.S., denoted y_{US} and the maximum aggregate interference by stations in Canada, denoted y_{CAN} . By restricting the max aggregate interference to not exceed that of Step (2a), this optimization attempts to push down the max aggregate interference for the country that did not set the value Z_2 obtained in Step (2a).

3.3 Step (3): Minimize the costs due to relocation.

The next step in determining the final channel assignment is to minimize the total relocation costs of moving stations to alternative channels in both the U.S. and in Canada. If there are multiple solutions where the same, or nearly the same, number of stations remain on their pre-auction channels and the maximum amount of aggregate new interference is the same, there may be an assignment with a lower total relocation cost. This optimization will seek an assignment that has the least total cost for stations remaining on air among all solutions that satisfy the objectives of Steps 1 and 2.

As described in the *Auction 1000 Procedures PN*, estimates of costs of relocation will be done as a categorical approach in order to simplify the determination of relocation costs and to minimize the administrative burden of obtaining a cost for each station on each possible channel.⁷ This categorical approach assigns to each station a weight based on a number of characteristics that generally make a station more costly to relocate. A higher number indicates that a station is estimated to be more costly to reassign to a new channel. The optimization software will use the categorical weights to choose a final television channel assignment plan that minimizes relocation costs by avoiding moving stations with the highest weights, when possible. Generally, a full power station will be more costly to move than a Class A station. Likewise, stations in the top 30 DMAs will generally be more costly to move than stations in the remaining DMAs. Therefore, full power stations in the top 30 DMAs will have a weight of 5; full power stations in all other DMAs will have a weight of 3, and Class A stations will have a weight of 1.⁸ In order to take account of considerations that will likely add significant costs to relocation, “1” will be added to a station’s base weight for each of the following factors: (1) a station has an antenna on a tower taller than 1000 feet, which requires a specialized crew; (2) a station has a tower in areas with significant ice and wind threat and may need improvements to satisfy “Rev. G” structural standards; (3) a station is collocated on a tower with four or more other television or radio entities; and (4) a station that will require known extraordinary means to move. Examples of these stations are described in the Widelity Report.⁹ These weights are meant to reflect relative difficulty when comparing two stations and do not capture all of the unique circumstances of each station; however, they may provide a simple and non-burdensome means of estimating relocation costs accurately enough to avoid the most costly and difficult relocations.

The final choice of weights for each station in the U.S. has been delegated to the Media Bureau, which may choose to modify this weighting structure to take into account additional information.¹⁰ Canada will provide weights similar to those used for the U.S.

The additional constant and subset for this optimization are defined here.

⁷ *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9104, para. 279.

⁸ The Widelity Report Case Studies was used as a basis for these relative values. We used Case Study 1 for Full Power Top 30 DMA: cost is approximately \$2.5 million, Case Study 2 for Full Power not Top 30: cost is approximately \$1.5 million, Case Study 3 for Class A stations: cost is approximately \$0.5 million.

⁹ Certain towers will require extraordinary means to move a station to a new channel. As described in the Widelity Report, stations at the following locations in the U.S. will be considered extraordinary: Mt. Sutro, Willis Tower, Hancock Building, Empire State Building, Times Square, Mount Mansfield, Lookout Mountain.

¹⁰ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9104–05, para. 280.

Subset:

S_H is the set of stations that will remain in their pre-auction band in both the U.S. and Canada.

For the U.S., these are stations that did not participate or exited the auction. All Canadian stations will remain in their pre-auction band.

Constants:

$r_{s,c}$ is the weight associated with moving a station s to channel c .

Z'_{can} is the maximum aggregate new interference for Canadian stations as determined in Step (2b), it is equal to the value y_{can} found in Step (2b).

Z'_{US} is the maximum aggregate new interference for U.S. stations as determined in Step (2b), it is equal to the value y_{can} found in Step (2b).

Model Formulation for Step (3):

$$\min Z_{3,band} = \sum_{s \in S_H} \sum_{c \in C_s} r_{s,c} x_{s,c}$$

Subject to:

$$\sum_{c \in C_s} x_{s,c} = 1 \quad \forall s \in S \quad (1)$$

$$x_{s,c} + x_{s',c} \leq 1 \quad \forall \{(s,c), (s',c)\} \in CoPairs \quad (2)$$

$$x_{s,c} + x_{s',c'} \leq 1 \quad \forall \{(s,c), (s',c')\} \in AdjPairs \quad (3)$$

$$x_{(s,c)} \in \{0,1\} \quad \forall s \in S, \forall c \in C_s \quad (4)$$

$$\sum_{s \in S_{band,US}^o} x_{s,c_s^o} \geq Z'_{1,band,US} \quad \forall band \quad (5)$$

$$\sum_{s \in S_{band,CAN}^o} x_{s,c_s^o} \geq Z'_{1,band,CAN} \quad \forall band \quad (6)$$

$$\sum_{(s',c') \in SC_{(s,c)}} pct_{s,c,s',c'} x_{s',c'} \leq y + y_{max}(1 - x_{s,c}) \quad \forall s \in S_{band,CAN}, c \in C_s \quad (7)$$

$$\sum_{(s',c') \in SC_{(s,c)}} pct_{s,c,s',c'} x_{s',c'} \leq y_{US} + y_{max}(1 - x_{s,c}) \quad \forall s \in S_{band,US}, c \in C_s \quad (8)$$

$$0 \leq y_{CAN} \leq Z'_{CAN} \quad (9)$$

$$0 \leq y_{US} \leq Z'_{US} \quad (10)$$

Explanation of Constraints:**1–4: Feasibility Constraints**

Constraints (1) through (4) are the pairwise interference constraints needed for any feasible assignment.

5–6: At least 95 percent of the number of stations found in each band for each country in Step (1) remain on their pre-auction channel.

Constraint (5) and (6) assure that at least 95 percent of the number of stations found in each country in each band in Step (1) remain at their pre-auction channel.

7-8: These constraints calculate the maximum aggregate interference for each country separately.

Constraints (7) and (8) calculate the maximum aggregate interference for each country separately.

9-10: These constraints require that the aggregate interference for each country be no more than that found in Step (2a)

$$0 \leq y_{US}, y_{CAN} \leq Z_2$$

Constraints (9) and (10) limits the aggregate new interference that any station can receive to be less than or equal to the maximum of the values found in Step (2a).

Explanation of Objective Function:

The objective function minimizes $Z_{3,band}$ the total relocation costs incurred for stations in that band. $Z_{3,band}$ will be greater than or equal to 0.

3.4 Step (4): Among solutions that satisfy the results of Steps (1)–(3), prioritize assignments to Channel 5 in the Low VHF band and avoid assignments of stations to Channel 14.

The fourth optimization will choose, among all assignments that satisfy the results of Steps (1)–(3), to assign Low-VHF stations to channel 5. The optimization will similarly attempt to assign stations to a channel other than channel 14 in order to avoid coordination challenges with private land mobile radio systems (PLMRS). As this optimization is only meant to choose between equivalent (or better) solutions to the results from the previous optimizations, the number of stations assigned to their original channel will be constrained to be at least as many as determined in the result of the third optimization.

The additional subsets and constant for this optimization are defined here.

Subset:

S_{LowV} is the set of stations that will be broadcasting in Low-VHF after the auction.

S_{UHF} is the set of stations that will be broadcasting in UHF after the auction.

Constants:

$\sigma_{s,c}$ is a weight for station s on channel c . A negative $\sigma_{s,c}$ will prioritize assignments to that channel, and a positive $\sigma_{s,c}$ will avoid assignments to that channel. $\sigma_{s,5}$ will equal -1, $\sigma_{s,14}$ will equal 1 and all other $\sigma_{s,c}$ will equal 0.

$Z''_{band,US}$ is the number of U.S. stations in each band on their original channel after Step (3). Note that $Z''_{band,US}$ must always be greater than or equal to $0.95 Z_{1,band,US}$ because of constraint (5) of Step (2b).

$Z''_{band,CAN}$ is the number of Canada stations in each band on their original channel after Step (3). Note that $Z''_{band,CAN}$ must always be greater than or equal to $0.95 Z_{1,band,CAN}$ because of constraint (5) of Step (2b).

Model Formulation for Step (4):

$$\min Z_{4,band} = \sum_{s \in S_{band}} \sigma_{s,c} x_{s,c}$$

Subject to:

$$\sum_{c \in C_s} x_{s,c} = 1 \quad \forall s \in S \quad (1)$$

$$x_{s,c} + x_{s',c} \leq 1 \quad \forall \{(s,c), (s',c)\} \in CoPairs \quad (2)$$

$$x_{s,c} + x_{s',c'} \leq 1 \quad \forall \{(s,c), (s',c')\} \in AdjPairs \quad (3)$$

$$x_{(s,c)} \in \{0,1\} \quad \forall s \in S, \forall c \in C_s \quad (4)$$

$$\sum_{s \in S_{band,US}^o} x_{s,c_s^o} \geq Z'_{1,band,US} \quad \forall band \quad (5)$$

$$\sum_{s \in S_{band,CAN}^o} x_{s,c_s^o} \geq Z'_{1,band,CAN} \quad \forall band \quad (6)$$

$$\sum_{(s',c') \in SC_{(s,c)}} p_{ct_{s,c,s',c'}} x_{s',c'} \leq y + y_{max}(1 - x_{s,c}) \quad \forall s \in S_{band,CAN}, c \in C_s \quad (7)$$

$$\sum_{(s',c') \in SC_{(s,c)}} p_{ct_{s,c,s',c'}} x_{s',c'} \leq y_{US} + y_{max}(1 - x_{s,c}) \quad \forall s \in S_{band,US}, c \in C_s \quad (8)$$

$$0 \leq y_{CAN} \leq Z'_{CAN} \quad (9)$$

$$0 \leq y_{US} \leq Z'_{US} \quad (10)$$

$$\sum_{s \in S_H} \sum_{c \in C_s} r_{s,c} x_{s,c} \leq Z_{3,band} \quad (11)$$

Explanation of Constraints:

1–4: Feasibility Constraints

Constraints (1) through (4) are the pairwise interference constraints needed for any feasible assignment.

5–6: At least 95 percent of the number of stations found in each band for each country in Step (1) remain on their pre-auction channel.

Constraint (5) and (6) assure that at least 95 percent of the number of stations found in each country in each band in Step (1) remain at their pre-auction channel.

7-8: These constraints calculate the maximum aggregate interference for each country separately.

Constraints (7) and (8) calculate the maximum aggregate interference for each country separately.

9-10: These constraints require that the aggregate interference for each country be no more than that found in Step (2a)

Constraints (9) and (10) limits the aggregate new interference that any station can receive to be less than or equal to the maximum of the values found in Step (2b).

11: These constraints limits total reassignment costs for each band to be less than that found in Step (3).

$$\sum_{s \in S_H} \sum_{c \in C_s} r_{s,c} x_{s,c} \leq Z_{3,band}$$

Constraint (11) limits the total reassignment costs for a band to be less than or equal to the value found in Step (3) for that band.

Explanation of Objective Function:

The objective function maximizes (minimizes the negative of) the number of Low-VHF stations assigned to channel 5 and minimizes the number of stations assigned to channel 14 in UHF.

APPENDIX F

Forward Auction Bidding Units, Upfront Payments, and Minimum Opening Bids

This page was intentionally inserted as a placeholder for Appendix F, which is available as a separate file.

APPENDIX G

Forward Auction Clock Phase

1 Introduction

This appendix provides a final version of Appendix G of the *Auction 1000 Comment PN* detailing the first part of the forward auction procedure adopted by the Commission in the *Auction 1000 Bidding Procedures PN*: the clock phase. Overall, this clock auction is designed to share some major features with the simultaneous multiple round auction (SMRA) format, but to run to completion in a fraction of the time that an SMRA would require. Like an SMRA, the clock phase of the forward auction proceeds through a sequence of ascending prices for the licenses. Also, like an SMRA with no bid withdrawals, once there is demand for a license in the auction, the license will not then go unsold. The clock auction design, however, includes three features that allow it to run in less time than the corresponding SMRA.

The first of these features is that the clock auction aggregates demand within each category of generic licenses, rather than treating each license as a distinct item for bidding. In a traditional SMRA, if during the auction, there were five units of demand for four very similar licenses, then at each round of the bidding, only one of the four licenses would have a new bid to raise its price. With that pattern of bidding it would take four rounds for all the license prices to rise by one bid increment. In a clock auction, by treating all four licenses as a single product, a single price increment applies to all, so the same price increase takes just one round, instead of four.

The second feature that is different in the clock auction design is the assignment phase, details of which are described in Appendix H. This feature is made necessary by the generic licenses structure, and highlights another important advantage of generic licenses in the incentive auction context. If the incentive auction used an SMRA with individually identified licenses, the auction rules would need to specify which of those licenses would be eliminated whenever the auction moves into a new stage. Uncertainty about not just the number of blocks that will be available, but also about which particular frequencies will be associated with the available blocks, would complicate bidding in the forward auction. By having a separate assignment phase to determine which particular frequencies each bidder will acquire, the auction allows each phase of the auction to perform a function for which it is best suited. Specifically, the clock phase identifies the number of licenses in each category that each bidder will acquire in a PEA, while the assignment phase determines the particular frequencies. This separation makes bidding much easier and, because it avoids solving the assignment problem except in the final stage, it reduces the time required for the auction.

The third feature that distinguishes this clock auction from the SMRA is *intra-round bidding*. This feature performs two important functions. First, it avoids price overshooting. If there were no intra-round bidding, the price for a category of blocks might rise so high in a round that a category with excess demand at the start of a round would have insufficient demand at the end of the round. With intra-round bidding, the price for a category stops rising as soon as demand falls to the level of supply, so there is no risk of overshooting. Second, intra-round bidding allows a clock auction to utilize larger bid increments than a corresponding SMRA, which helps bring the auction to a close more quickly. In an SMRA, the bid increments must be set small enough that a bidder who is willing to raise a price can afford to do so without exceeding its maximum price. In a clock auction with intra-round bidding, however, a bidder can specify the highest price between the beginning and end of round prices at which it wishes to maintain its current demand, so that a bidder will not be deterred from further bidding when the full bid increment is larger than it is willing to pay.

In order for the clock auction design to achieve these benefits, it needs to include bid types that allow bidders to execute strategies similar to the ones they would use in an SMRA. This appendix describes three kinds of bidding plans that bidders commonly execute in an SMRA, and the corresponding three types of bids that facilitate those strategies in this clock auction. First, in an SMRA, when the price of a

license becomes too high, a bidder can reduce demand by refraining from bidding again on that license. In the clock auction design, the *simple* bid performs that same function, that is, it allows a bidder to reduce demand for a category when its price rises above any price that the bidder may identify. Second, in an SMRA, when one license price rises too high compared to that of another license (in the same PEA), a bidder can stop bidding for the first license and start bidding for the second. In the clock auction, a bidder can do the same by making a *switch* bid, in which it specifies that it will shift demand from one category to the other when the price of the first category gets too high. Finally, suppose that for some category, a bidder wants to buy two blocks if the price is sufficiently low, but wants to avoid acquiring just one block of that type. In an SMRA, when the prices of a set of licenses are rising, the bidder can limit the possible outcomes by refraining from raising its bid on one license and waiting to see what happens, possibly using a waiver. If there is demand by other bidders for both of its licenses, it can then stop bidding on both. In this clock auction design, a bidder can accomplish the same by use of an *all-or-nothing* bid for a category. In the example, a bidder that is currently demanding two blocks of one category can specify that it will reduce its demand for that category to zero, but that it will not reduce its demand to just one block at the specified price.

The remainder of this document describes the procedures that accomplish all this in more detail, including technical descriptions of the various calculations.

2 Overview

The clock phase of the forward auction will consist of a series of timed bidding rounds. During each bidding round, bidders will place bids indicating demand for generic blocks in a particular license category in a particular PEA, at a price they specify between the start of round price and the end of round price (the *clock price*). After each bidding round closes, the bids are processed. Bid processing determines the quantity of a bidder's requested demand that is applied (the *processed demand*) and the start of round price of each product for the next round, if there is to be a next round (the *posted price*). After the bids are processed the system determines whether the next round will be a regular clock round or an *extended round*, or, if the final stage rule is met and there is no excess demand for blocks in any category in any PEA (indicating satisfaction of the closing conditions), the clock phase of the forward auction will end. Finally, the auction system sets up the next round, if there is to be one, including calculating the prices for each category in each PEA for the next round.

Section 3 describes several rules and definitions that are useful in understanding how the forward auction functions. Section 4 describes the bidding rules. Section 5 describes the calculations for the bidding information that is shown to bidders. Section 6 describes the types of bids bidders can place in the clock rounds of the forward auction. Section 7 describes bid processing in a regular clock round. Section 8 describes how the system checks whether the closing conditions have been met, and if not, determines the round type for the next bidding round. Section 9 describes how the system sets up that next round. Section 10 describes the bid processing steps performed for an extended round. Finally, Section 11 describes how the system handles the mobile spectrum holdings reserve split.

3 Rules and Definitions

This section describes several rules and definitions that are useful in understanding how the forward auction functions.

3.1 Products

A product is defined to be the pairing of a PEA and a license category. Before the spectrum reserve split, there are at most two products in each PEA. After the spectrum reserve split, there are at most three products in each PEA.

3.2 Extended Round Products

The *extended round products* are the Category 1 products in the 40 high-demand PEAs for which aggregate processed demand is equal to supply at the time that the extended round is triggered. The set of extended round products is denoted by “ER.”

If there are any Category 1 products in high-demand PEAs for which aggregate processed demand is strictly less than supply, those products will not be included for bidding in the extended round. Note that an extended round is not triggered unless the aggregate processed demand is less than or equal to supply for every Category 1 product in a high-demand PEA.

3.3 Acceptable Bids

Acceptable bids are ones that can be applied in full or in part when they come up for processing in a round. No bid will be applied that reduces the aggregate demand for blocks in a category below the available supply. This processing restriction ensures that once the final stage rule has been met, revenue cannot fall below what is required to meet the final stage rule. Specifically, by not allowing aggregate demand to fall below supply, the total proceeds of the forward auction can only stay the same or increase each round.

As a result of this restriction, some bids that request a reduction in the number of blocks in a category demanded by a bidder may not be applied in their entirety. Moreover, a bid that requests an increase in the number of blocks in a category demanded by a bidder will not be applied in its entirety if the bidder does not have sufficient bidding eligibility.

This section describes the circumstances under which a bid is applied either fully or partially.

3.3.1 Fully Acceptable Bids

A bid is *fully acceptable* if, at the time it is considered during processing, the following conditions both hold:

- (a) If the bid were applied in its entirety, the total number of bidding units associated with the bidder’s demand would not exceed the bidder’s eligibility in the current round;
- (b) If the bid were applied in its entirety, the aggregate demand would not be less than the supply for that product.

Only bids that are fully acceptable will be applied in their entirety during bid processing, with the following exception in the case that the auction transitions to a new stage:

In the first round of a new stage, a bid to reduce demand for a Category 2 product is considered fully acceptable even if condition (b) above is not satisfied. That is, such a bid will be applied in full during bid processing, even if there is no excess demand at the time the bid is considered during bid processing. This relaxation of the rule in the first round of a new stage allows bidders to adjust their demand for a Category 2 product if the supply and impairments of the blocks of that product have changed significantly as a result of lowering the clearing target and re-optimizing the location of impairing stations in the 600 MHz Band.

3.3.2 Partially Acceptable Bids

If a bid is not fully acceptable, it may be considered *partially acceptable* if, at the time it is considered during processing, the following conditions both hold:

- (a’) If the bid were applied *partially*, the total number of bidding units associated with the bidder’s demand would not exceed the bidder’s eligibility in the current round; and

(b') If the bid were applied *partially*, the aggregate demand would not be less than the supply for that product.

Examples of fully and partially applied bids are provided in Section 6.

3.4 Activity and Eligibility

A bidder's *processed activity* is equal to the total number of bidding units associated with the bidder's processed demand after the bid processing of the round.

An activity rule is used in the forward auction in order to require bidders to participate in each round of the auction. A bidder's eligibility in round 1 of stage 1 of the forward auction is determined by the bidding units associated with its upfront payment. A bidder's eligibility in subsequent rounds of any stage is calculated based on its eligibility in the previous round, its processed activity, and the activity requirement. A different calculation is used to calculate a bidder's eligibility in round 1 of a new stage if the last round of the prior stage was an extended round. See the calculations in Sections 9.1 and 9.2 for details.

4 Bidding

A bidder in the forward auction responds in each round by indicating its demand for blocks of the products it desires at current prices. When submitting a bid, the bidder specifies a quantity and a price. The price can be last round's posted price, this round's clock price, or any price in between (an "intra-round bid"). In each round, bidders may place multiple bids, including multiple bids for the same product. For example, a bidder that begins a round with processed demand of 4 units of some product might reduce its demand for that product from 4 to 3 at a price of \$5,500 and from 3 to 2 at a price of \$5,800.

In order to give bidders flexibility to express their demands, the forward auction includes three different types of bids: simple bids, all-or-nothing bids (with an option of "backstopping" the all-or-nothing bid), and switch bids. Section 6 provides a detailed explanation of each bid type along with examples to illustrate each of these bid types and how the auction system will process them.

4.1 Bidding Rules

In the first round of the auction, bidders may only submit a bid for a product at the *opening price* for that product. For all rounds subsequent to round one, bidders may submit a bid for a product at a price that is a whole dollar amount greater than or equal to the last round's *posted price* for that product and less than or equal to the current round's *clock price* for that product.

In every round, a bidder may only bid for a quantity that is greater than or equal to 0 and less than or equal to the supply for that product.

A bidder will *not* be allowed to submit a bid or collection of bids if the bidder's *activity* for the round would exceed its *current eligibility*.

A bidder may submit a bid on a reserved product only if the bidder is reserve-eligible in the PEA associated with that product.

In any round after the spectrum reserve has been triggered, a bidder that is reserve-eligible in a PEA subject to the small market bidding cap cannot bid for 3 (or more) blocks of the reserved product in that PEA.

In an extended round, a bidder may only bid on extended round products (see Section 3.2 for the definition). Also in an extended round, a bidder may only submit a simple bid for a quantity equal to either its current processed demand for that product or one block less.

In any regular clock round, a bidder may only submit one of the three types of bids for a given product: simple bids, all-or-nothing bids, or switch bids. However, it can submit multiple bids of the same type for a given product. For example, if a bidder places a simple bid for product A, then it cannot submit an all-or-nothing bid for product A nor can it submit a switch bid that involves product A in the same round.

A bidder may *not* submit two different bids that involve the same product at the same price. For example, the bidder cannot submit a simple bid for 2 blocks of product A and a simple bid for 0 blocks of product A both at the same price. Similarly, if A, B and C are products in the same PEA, the bidder cannot submit a bid to switch one block from A to B and another bid to switch one block from A to C both at the same price¹.

A bidder may *not* submit two bids for the same product that involve the same quantity at different prices. For example, the bidder cannot submit a simple bid for 2 blocks of product A at price \$1,050 and a simple bid for 2 blocks of product A at price \$1,070.

All of the bids submitted by a bidder in a round for a product must be *one-directional* in terms of price. That is, if all of the bids submitted by a bidder in a round for a product are put in ascending order by price, the corresponding quantities must all either increase or decrease starting from the bidder's processed demand from the previous round. The algorithm that determines *one-directionality* is described below.

4.1.1 Algorithm for One-directionality

The following algorithm illustrates how one can check one-directionality for bidder i and a given product r . Let A denote the set of bids that the bidder has just requested to submit, and B denote the set of bids that the bidder has already submitted in this round.²

The algorithm looks at all bids for product r in A and B . It ranks them in price order, then checks the direction of the change and validates that all bids at higher prices maintain the same direction.

- Let A_r consist of all bids in A that involve product r . This includes switch bids for which r is the "to" product. Each element of A_r is represented by the pair (price, quantity for product r).
- Similarly, let B_r consist of all bids in B that involve product r . Each element of B_r is represented by the pair (price, quantity for product r).
- Let S denote the union of A_r , B_r and the following element: (posted price of previous round for product r , processed demand from previous round for product r)
- Rank all elements of S in ascending order of price, and let q be the corresponding vector of quantities. That is, $q(1)$ is the processed demand from the previous round, $q(2)$ is the quantity associated with the lowest-price bid for product r in $A \cup B$, etc. Let N be the number of elements in q .
- Check whether one of the following conditions holds:
 - (i) $q(2) \geq q(1)$ and $q(k) > q(k-1)$ for $k = 3, 4, \dots, N$.
 - (ii) $q(2) \leq q(1)$ and $q(k) < q(k-1)$ for $k = 3, 4, \dots, N$.

¹ If the bidder were allowed to submit such bids, the system would need to randomly select which bid to process first.

² If the set of bids $A \cup B$ includes at least one switch bid where product r is the "to" product, then one-directionality for product r is satisfied if and only if all bids in $A \cup B$ that involve product r are switch bids with r as the "to" product. See Section 6.3 for details on switch bids.

If either (i) or (ii) is satisfied, bids in A are one-directional with the bids in B and the bidder's processed demand from the previous round for product r . If the bids in A are one-directional with the bids in B and the bidder's processed demand from the previous round for all products, then the system allows the bidder to submit the bids in A . Otherwise, the bids in A are not submitted.

Example:

Suppose that the bidder's processed demand for product r from the previous round is 4, and the posted price is \$5,000. In the current round, the clock price is \$6,000. The bidder has already submitted the bids $B_r = \{(\$5,300, 2), (\$5,400, 0)\}$ for product r in this round. The bidder is now trying to submit the bids $A_r = \{(\$5,100, 3), (\$5,200, 1)\}$ for product r . Then,

$$S = \{(\$5,000, 4), (\$5,100, 3), (\$5,200, 1), (\$5,300, 2), (\$5,400, 0)\}$$

The following table shows the prices and quantities of the elements of S , ranked in order of price:

k	Price	$q(k)$
1	\$5,000	4
2	\$5,100	3
3	\$5,200	1
4	\$5,300	2
5	\$5,400	0

Observe that $q(2) < q(1)$ but $q(4) > q(3)$. Thus, the bidder will not be allowed to submit the bids in A_r .

5 Calculations for Bidding Information

In the following sections, N denotes the set of all products.

5.1 Activity – Regular Clock Round

When a regular clock round is open for bidding, the *activity* of a bidder is calculated as the total number of bidding units associated with the demand the bidder indicates it is willing to accept at the clock price, given all bids that the bidder has submitted. In other words, the activity of bidder i is given by the following sum:

$$\sum_r q_{i,r} \cdot b_r$$

Where:

- $q_{i,r}$ denotes the requested demand of bidder i for product r at the clock price, given all bids that bidder i has submitted so far in this round. In particular, if all the bids that are submitted by bidder i for product r are applied during bid processing, then its processed demand will be $q_{i,r}$.
- b_r denotes the number of bidding units associated with product r

At the beginning of a round, *i.e.*, before the bidder has submitted any bids in this round, the bidder's activity is equal to 0.

Example:

Product A has 10 bidding units and product B has 8 bidding units. For product A, the clock price is \$6,000, and the previous round's posted price is \$5,000. For product B, the clock price is \$4,800, and the previous round's posted price is \$4,000. Suppose that bidder i has submitted the following bids in the current bidding round:

- Product A: a simple bid for 4 blocks at price \$5,500, and a simple bid for 2 blocks at price \$5,700.
- Product B: an all-or-nothing bid for 2 blocks at price \$4,500.

After the bidder has submitted these three bids, its activity is: $(2 \cdot 10) + (2 \cdot 8) = 36$ bidding units.

5.2 Activity – Extended Round

When an extended round is open for bidding, the *activity* of a bidder is calculated as the sum of (1) the total number of bidding units associated with the bidder's demand at the clock price, given all bids that the bidder has submitted so far for all *ER* products;³ and (2) the total number of bidding units associated with the bidder's processed demand from the last round for all non-*ER* products (this component does not change during the extended round). In other words, the activity of bidder i is given by the following formula:

$$\sum_{r \in N \setminus ER} d_{\tau,i,r} \cdot b_r + \sum_{r \in ER} q_{i,r} \cdot b_r$$

Where:

- $d_{\tau,i,r}$ denotes the processed demand from the last round of bidder i for product r , i.e., its processed demand at the time that the extended round is triggered.
- $q_{i,r}$ denotes the requested demand of bidder i for product r in the extended round, given all bids that bidder i has submitted so far. In particular, if the bidder submitted a bid for its processed demand from the last round for product r at the clock price of the extended round, then $q_{i,r}$ is equal to the bidder's processed demand from the last round for product r . If the bidder submitted a bid to reduce its demand by one block in the extended round, then $q_{i,r}$ is equal to the bidder's processed demand from the last round for product r minus one. If the bidder's processed demand from the last round for product r is 0, then $q_{i,r} = 0$.
- b_r denotes the number of bidding units associated with product r .

At the beginning of an extended round, i.e., before the bidder has submitted any bids in this round, the bidder's activity is equal to the total number of bidding units associated with (i) the bidder's processed demand from the last round for all non-*ER* products (the first term in the formula above) and (ii) one less than the bidder's processed demand from the last round for all *ER* products for which it has a positive processed demand. This is given by the following formula:

$$\sum_{r \in N \setminus ER} d_{\tau,i,r} \cdot b_r + \sum_{r \in ER: d_{\tau,i,r} > 0} (d_{\tau,i,r} - 1) \cdot b_r$$

5.3 Required Activity

A bidder's *required activity* in round t is the minimum total number of bidding units associated with the bidder's processed demand that the bidder should have after the bid processing of round t in order to

³ *ER* denotes the set of extended round products (see Section 3.2).

maintain the same eligibility in round $t + 1$. The bidder's required activity in round t is calculated according to the following formula:

$$\text{Required Activity}(t) = \text{Eligibility}(t) \cdot \text{ActivityRequirement}$$

Where:

- *Eligibility*(t) denotes the bidder's eligibility in round t .
- *ActivityRequirement* denotes the activity requirement. This is a percentage (up to 100 percent) set by the FCC.

5.4 Requested Commitment – Regular Clock Round

For the convenience of bidders, the auction software will provide the following additional information about the financial exposure created by bids during the course of the auction. A bidder's *requested commitment* during a regular clock round t is the total gross bid amount calculated at the round's clock prices, given the bids that the bidder has submitted so far in round t . During the round, bids for the round have not yet been processed, so the requested commitment is an estimate of a bidder's commitment, which is updated as bids are submitted. The requested commitment of bidder i in a regular clock round t is calculated according to the following formula:

$$\sum_{r \in N} q_{i,r} \cdot P_{t,r}$$

Where:

- $q_{i,r}$ denotes the requested demand of bidder i for product r at the clock price, given all bids that bidder i has submitted so far in this round. In particular, if all the bids that are submitted by bidder i for product r are applied during bid processing, then its processed demand will be $q_{i,r}$.
- $P_{t,r}$ denotes the clock price in round t for product r

At the beginning of a round, *i.e.*, before the bidder has submitted any bids in this round, the bidder's requested commitment is equal to 0.

Example:

For product A, the clock price is \$6,000, and the previous round's posted price is \$5,000. For product B, the clock price is \$4,800, and the previous round's posted price is \$4,000. Suppose that bidder i has submitted the following bids in the current bidding round:

- Product A: a simple bid for 4 blocks at price \$5,500, and a simple bid for 2 blocks at price \$5,700.
- Product B: an all-or-nothing bid for 2 blocks at price \$4,500

By placing these bids, the bidder indicates that it is willing to buy 2 blocks of product A up to and including the clock price of \$6,000 per block, and 2 blocks of product B up to and including the clock price of \$4,800 per block. After submitting these three bids, the bidder's requested commitment is:

$$(2 \cdot \$6,000) + (2 \cdot \$4,800) = \$21,600$$

5.5 Requested Commitment – Extended Round

In an extended round, the requested commitment of bidder i is equal to:

$$\sum_{r \in N \setminus ER} d_{\tau,i,r} \cdot p_{\tau,r} + \sum_{r \in ER} q_{i,r} \cdot Bid Price_r$$

Where:

- τ denotes the last round before the extended round
- $d_{\tau,i,r}$ denotes the processed demand of bidder i for product r after the bid processing of round τ , *i.e.*, at the time that the extended round is triggered
- $p_{\tau,r}$ denotes the posted price for product r in round τ
- $q_{i,r}$ denotes the requested demand of bidder i for product r in the extended round, given all bids that bidder i has submitted so far. In particular, if the bidder submitted a bid for its processed demand from the last round for product r at the clock price of the extended round, then $q_{i,r}$ is equal to the bidder's processed demand from the last round for product r . If the bidder submitted a bid to reduce its demand by one block in the extended round, then $q_{i,r}$ is equal to the bidder's processed demand from the last round for product r minus one. If the bidder's processed demand from the last round for product r is 0, then $q_{i,r} = 0$.
- $Bid Price_r$ denotes the price in the bidder's bid for product r in the extended round. If in the extended round the bidder has not submitted a bid for a product r for which $d_{\tau,i,r} > 0$, then $Bid Price_r$ is set equal to the posted price from the previous round, *i.e.*, $Bid Price_r = p_{\tau,r}$.

Note that the first summation is across all non-ER products, whereas the second summation is across all ER products. See Section 3.2 for the definition of extended round products (ER).

At the beginning of a round, *i.e.*, before the bidder has submitted any bids in this round, the bidder's requested commitment is given by the following formula:

$$\sum_{r \in N \setminus ER} d_{\tau,i,r} \cdot p_{\tau,r} + \sum_{r \in ER: d_{\tau,i,r} > 0} (d_{\tau,i,r} - 1) \cdot p_{\tau,r}$$

5.6 Bidding Credit Discounts on Requested Commitment

This section describes the calculations for requested commitment bidding credit discounts in a round t . All bidding credit discounts are rounded to the nearest dollar.

The following notation is used:

- BC_i denotes the bidding credit percentage of bidder i .
- $RC_{t,i}$ denotes the requested commitment of bidder i in round t .⁴
- S denotes the set of all products in *small markets* (*i.e.*, markets subject to the small market bidding cap)⁵

⁴ Note that a bidder's requested commitment may change when the bidder submits or changes its bids.

⁵ Markets that are subject to the small market bidding credit cap are those PEAs with a population of 500,000 or less, which corresponds to PEAs 118–416, excluding PEA 412. *Updating Part 1 Competitive Bidding Rules*, WT Docket No. 14-170, Report and Order, 30 FCC Rcd 7493, 7546, para. 127 (2015) (“[N]o winning DE bidder will be (continued....)”).

5.6.1 Rural Bidding Credit

If bidder i qualifies for the rural bidding credit, then in round t

- Its *uncapped requested commitment discount* is:

$$BC_i \cdot RC_{t,i}$$

- Its *capped requested commitment discount* is:

$$\min\{\$10 \text{ million}, BC_i \cdot RC_{t,i}\}$$

This is equal to the bidder's requested commitment multiplied by its bidding credit and then capped at \$10 million.

5.6.2 Small Business Bidding Credit – Regular Clock Round

If bidder i qualifies for the small business bidding credit, then in a regular clock round t

- Its *uncapped requested commitment discount in small markets* is:

$$BC_i \cdot \sum_{r \in S} q_{i,r} \cdot P_{t,r}$$

Note that the summation is across all products in small markets. The uncapped requested commitment discount in small markets is calculated by multiplying the bidder's requested commitment in small markets with its bidding credit.

- Its *uncapped requested commitment discount* (across all markets) is:

$$BC_i \cdot RC_{t,i}$$

- Its *capped requested commitment discount* (across all markets) is:

$$\min\left\{\$150 \text{ million}, BC_i \cdot \sum_{r \in N \setminus S} q_{i,r} \cdot P_{t,r} + \min\left\{\$10 \text{ million}, BC_i \cdot \sum_{r \in S} q_{i,r} \cdot P_{t,r}\right\}\right\}$$

This calculation first caps the bidder's discount in small markets at \$10 million, then adds the bidder's discount from all other markets (*i.e.*, markets that are not subject to the small market bidding cap) and caps the sum at \$150 million.

5.6.3 Small Business Bidding Credit – Extended Round

If bidder i qualifies for the small business bidding credit, then in an extended round t :

- Its *uncapped requested commitment discount in small markets* is:

(Continued from previous page) _____
 able to obtain more than \$10 million in bidding credits for licenses won in PEAs 118416, with the exception of PEA 412 (Puerto Rico), which exceeds the 500,000 pop threshold.”).

$$BC_i \cdot \sum_{r \in S} d_{t,i,r} \cdot p_{t,r}$$

The summation is across all products in small markets. Note that products in small markets are not bid on in the extended round. The uncapped requested commitment discount in small markets is calculated by multiplying the bidder's requested commitment in small markets with its bidding credit.

- Its *uncapped requested commitment discount* (across all markets) is:

$$BC_i \cdot RC_{t,i}$$

This is just the bidder's requested commitment multiplied by its bidding credit.

- Its *capped requested commitment discount* (across all markets) is:

$$\min \left\{ \$150 \text{ million}, BC_i \cdot \left(\sum_{r \in N \setminus (ERUS)} d_{t,i,r} \cdot p_{t,r} + \sum_{r \in ER} q_{i,r} \cdot \text{Bid Price}_r \right) \right. \\ \left. + \min \left\{ \$10 \text{ million}, BC_i \cdot \sum_{r \in S} d_{t,i,r} \cdot p_{t,r} \right\} \right\}$$

This calculation first caps the bidder's discount in small markets at \$10 million, then adds the bidder's discount from all other markets (*i.e.*, markets that are not subject to the small market bidding cap) and caps the sum at \$150 million.

5.7 Requested Net Commitment

A bidder's *requested net commitment* is equal to the difference between its requested commitment and its capped requested commitment discount.

5.8 Commitment (from previous round)

The bidder's *commitment* from the previous round is a dollar value that is calculated from the bidder's processed demand and the posted prices after the bid processing of the previous round.

The commitment of bidder *i* after round *t* is given by the following formula:

$$\sum_{r \in N} d_{t,i,r} \cdot p_{t,r}$$

Where:

- $d_{t,i,r}$ denotes the processed demand of bidder *i* for product *r* after round *t*.
- $p_{t,r}$ denotes the posted price of product *r* after round *t*.

5.9 Bidding Credit Discounts on Commitment (from previous round)

This section describes the calculations for commitment bidding credit discounts after a round *t*. All bidding credit discounts are rounded to the nearest dollar.

The following notation is used:

- BC_i denotes the bidding credit percentage of bidder i .
- $C_{t,i}$ denotes the commitment of bidder i after round t .
- S denotes the set of all products in *small markets* (*i.e.*, markets subject to the small market bidding cap).

5.9.1 Rural Bidding Credit

If bidder i qualifies for the rural bidding credit, then after round t

- Its *uncapped commitment discount* is:

$$BC_i \cdot C_{t,i}$$

- Its *capped commitment discount* is:

$$\min\{\$10 \text{ million}, BC_i \cdot C_{t,i}\}$$

This is equal to the bidder's commitment multiplied by its bidding credit and then capped at \$10 million.

5.9.2 Small Business Bidding Credit

If bidder i qualifies for the small business bidding credit, then after round t

- Its *uncapped commitment discount in small markets* is:

$$BC_i \cdot \sum_{r \in S} d_{t,i,r} \cdot p_{t,r}$$

Note that the summation is across all products in small markets. The uncapped commitment discount in small markets is calculated by multiplying the bidder's commitment in small markets with its bidding credit.

- Its *uncapped commitment discount* (across all markets) is:

$$BC_i \cdot C_{t,i}$$

- Its *capped commitment discount* (across all markets) is:

$$\min \left\{ \$150 \text{ million}, BC_i \cdot \sum_{r \in N \setminus S} d_{t,i,r} \cdot p_{t,r} + \min \left\{ \$10 \text{ million}, BC_i \cdot \sum_{r \in S} d_{t,i,r} \cdot p_{t,r} \right\} \right\}$$

This calculation first caps the bidder's discount in small markets at \$10 million, then adds the bidder's discount from all other markets (*i.e.*, markets that are not subject to the small market bidding cap) and caps the sum at \$150 million.

5.10 Net Commitment (from previous round)

A bidder's *net commitment* after round t is the bidder's commitment after round t minus its capped commitment discount.

6 Bid Types

The types of bids are:

Simple Bids: These bids indicate a desired quantity of a product at a price. During processing, if it is not possible to apply the simple bid in its entirety, it may be applied partially.

All-or-Nothing Bids: These bids indicate a desired quantity of a product at a price, just like simple bids. However, all-or-nothing bids are either applied in full or not at all. These bids are available for a bidder that does not wish to place bids that may only be applied partially. As described in more detail below, if a bidder's all-or-nothing bid is not applied (because it cannot be applied in full), the auction system allows a bidder to place a "backstop" bid if it is not willing to demand its current processed demand at the clock price of this round.

Switch Bids: These bids allow a bidder to request to switch its demand for a quantity of a product from one category of generic blocks to another category within the same PEA. Switch bids may be applied partially, but the increase in demand in the "to" category will always match in quantity the reduction in the "from" category.

Below, a more detailed explanation is provided along with examples to illustrate each of these bid types and how the auction system will process them.

6.1 Simple Bids

A *simple bid* requesting to reduce demand to a quantity q for a product r at price p in a round indicates that:

- (1) At all prices above p and less than or equal to the clock price (or the next price at which the bidder submitted a bid), the bidder is willing to buy an exact quantity equal to q ; and
- (2) At price p , the bidder is willing to buy any quantity between q and its previous demand for product r .⁶

By placing one (or more) *simple bid(s)* requesting to increase demand for a product r at one (or more) price(s) in a round, the bidder indicates that at all prices associated with this round (*i.e.*, prices that are greater than or equal to the last round's posted price and less than or equal to the clock price) it is willing to buy any quantity that is greater than or equal to its processed demand and less than or equal to the maximum quantity that it specifies in a bid for product r .⁷

A *simple bid* for a quantity equal to the bidder's processed demand for a product r at the round's clock price indicates that the bidder is willing to buy a quantity equal to the last round's processed demand at all prices in this round up to and including this round's clock price.

Example: Bidder Places a Simple Bid Requesting to Reduce Demand to 2 Blocks at \$5,500

Suppose that after the bids of the previous round are processed, the bidder's processed demand for a product is 4 blocks and the posted price is \$5,000. In the current round, the clock price is \$6,000, and the bidder places a single simple bid for the product requesting to reduce its demand to 2 blocks at price \$5,500.

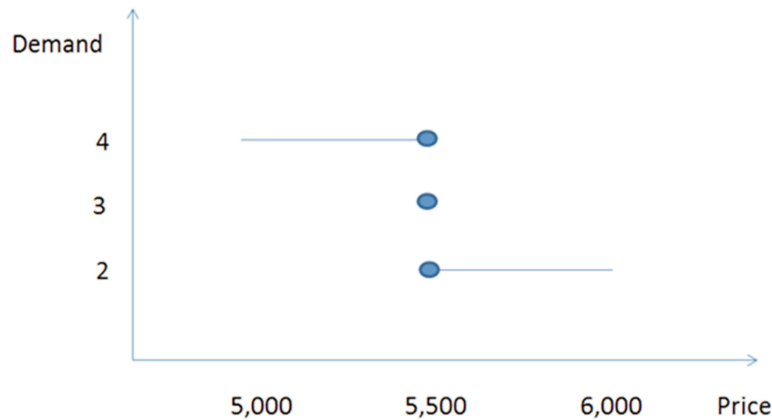
⁶ The bidder's previous demand for product r is either equal to its processed demand from the previous round or, if the bidder has placed a simple bid at a price below p for product r , the quantity in the bid for product r with the highest price below p .

⁷ The auction system will not process the requested increase until bid processing reaches the price point at which the bid was made, but depending upon demand for the product relative to its supply and upon which bids to reduce demand for the product are applied, the posted price for the current round may be above or below the bid price of the requested increase. The posted price may be lower if, for example, applying the increase allows another bidder's requested decrease at a lower price point to be applied.

To the auction system, this bid means the following:

- If the price is below \$5,500, the bidder is willing to purchase 4 blocks.
- If the price is exactly \$5,500, the bidder is willing to purchase 2, 3, or 4 blocks.
- If the price is above \$5,500, the bidder is willing to purchase only 2 blocks.

The graph below illustrates how the auction system interprets this simple bid:



If a simple bid is partially applied, then the processed demand of the bidder is a quantity that is strictly between the bidder's processed demand before the simple bid was applied and the quantity that the bidder specified in the bid.

When the auction system processes the bids at price \$5,500, the simple bid will be applied fully, partially, or not at all depending on the level of excess demand at that point in the bid processing.

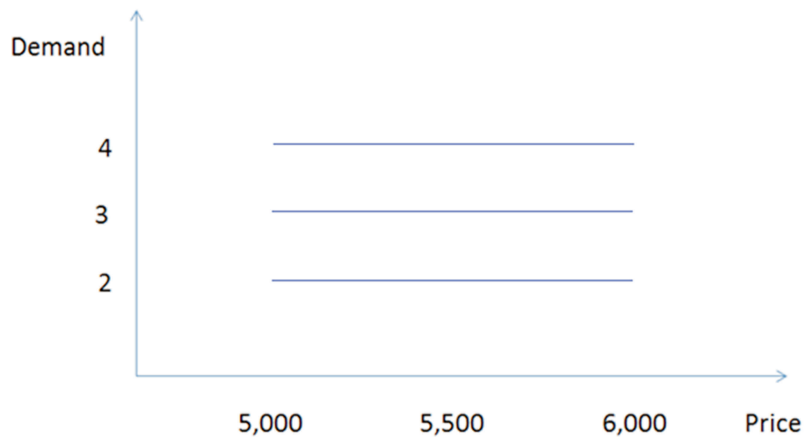
- (a) If demand exceeds supply by more than 2 blocks, the bid is fully applied. The bidder will hold 2 blocks.
- (b) If demand exceeds supply by exactly 2 blocks, the bid is also fully applied. The bidder will hold 2 blocks.
- (c) If demand exceeds supply by only 1 block, the bid is partially applied. The bidder will hold 3 blocks.
- (d) If demand does not exceed supply, the bid is not applied. The bidder will continue to hold 4 blocks.

Using the same bid, if no other bidder has submitted a bid requesting to change its demand for this product, then:

- In case (a), the posted price will be equal to \$6,000.
- In cases (b) and (c), the posted price will be equal to \$5,500.
- In case (d), the posted price will be equal to \$5,000.

Example: Bidder Places a Simple Bid Requesting to Increase Demand to 4 Blocks at \$5,500

Suppose that after the bids of the previous round are processed, the bidder's processed demand for a product is 2 blocks and the posted price is \$5,000. In the current round, the clock price is \$6,000, and the bidder places a single simple bid for the product requesting to increase its demand to 4 blocks at price \$5,500. This means that for all prices p such that $\$5,000 \leq p \leq \$6,000$, the bidder is willing to buy 2, 3, or 4 blocks. The corresponding demand graph is shown in the following figure:



6.2 All-or-Nothing Bids

An *all-or-nothing bid* is a request to increase or reduce demand for a given product by two or more blocks. An all-or-nothing bid will be applied only if it is fully acceptable.

An all-or-nothing bid requesting to reduce demand to a quantity q for a product r at price p in a round indicates that:

- (1) If the bid is fully acceptable (see Section 3.3.1 for the definition), the bidder is willing to buy an exact quantity of q of product r when the price is greater than or equal to p and less than or equal to the current clock price (or the next price at which it submitted a bid).
- (2) If the bid is not fully acceptable, the bidder is willing to buy a quantity equal to its previous demand⁸ for product r without applying this bid when the price is greater than or equal to p and less than or equal to the current clock price.

By placing one (or more) *all-or-nothing bid(s)* requesting to increase demand for a product r at one (or more) price(s) in a round, the bidder indicates that at all prices associated with this round (*i.e.*, prices that are greater than or equal to the last round's posted price and less than or equal to the clock price) it is willing to buy its processed demand and any quantity that it specified in an all-or-nothing bid for product r .

Example: Bidder Places an All-or-Nothing Bid Requesting to Reduce Demand to 2 Blocks at \$5,500

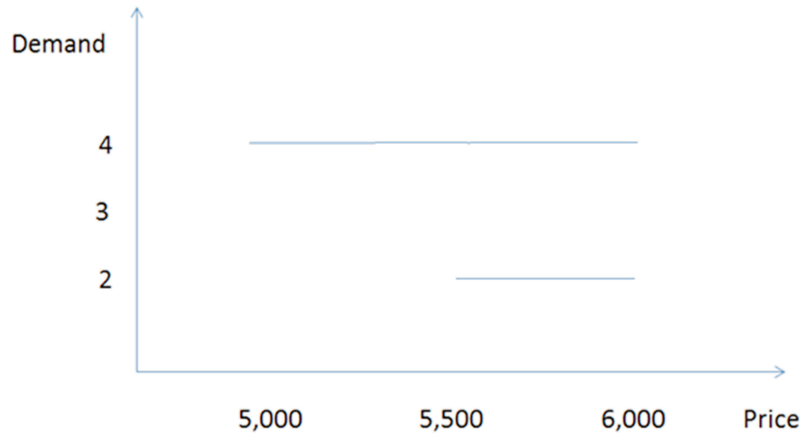
Suppose that after the bids of the previous round are processed, the bidder's processed demand for a product is 4 blocks and the posted price is \$5,000. In the current round, the clock price is \$6,000, and the bidder places a single all-or-nothing bid requesting to reduce its demand to 2 blocks at price \$5,500.

To the auction system, this bid means the following:

- If the price is below \$5,500, the bidder is willing to purchase 4 blocks.
- If the price is \$5,500 or higher, the bidder is willing to purchase either 2 or 4 blocks (depending on whether the all-or-nothing bid is fully acceptable), but not 3 blocks.

⁸ The bidder's previous demand for product r is either equal to its processed demand from the previous round or, if the bidder has placed an all-or-nothing bid at a price below p for product r , the bid quantity for product r with the highest price below p .

The graph below illustrates how the auction system interprets this all-or-nothing bid:



When the auction system processes the bids at price \$5,500, the all-or-nothing bid will either be applied fully or not at all depending on the level of excess demand at that point in the bid processing.

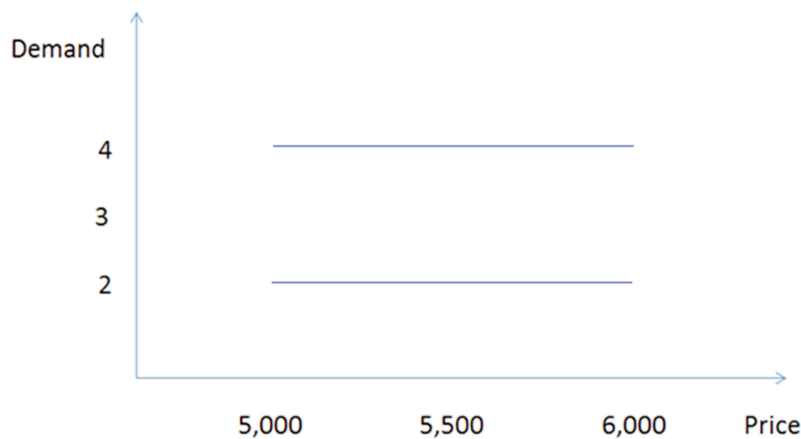
- (a) If demand exceeds supply by more than 2 blocks, the bid is fully applied. The bidder will hold 2 blocks.
- (b) If demand exceeds supply by exactly 2 blocks, the bid is also fully applied. The bidder will hold 2 blocks.
- (c) If demand exceeds supply by 1 block, the bid is not applied at all. The bidder will hold 4 blocks.
- (d) If demand does not exceed supply, the bid is not applied at all. The bidder will hold 4 blocks.

Continuing the same example, if no other bidder has submitted a bid requesting to change its demand for this product, then:

- In cases (a) and (c), the posted price will be equal to \$6,000.
- In case (b), the posted price will be equal to \$5,500.
- In case (d), the posted price will be equal to \$5,000.

Example: Bidder Places an All-or-Nothing Bid Requesting to Increase Demand to 4 Blocks at \$5,500

Suppose that after the bids of the previous round are processed, the bidder's processed demand for a product is 2 blocks and the posted price is \$5,000. In the current round, the clock price is \$6,000. By placing a single all-or-nothing bid for 4 blocks for the product at price \$5,500, the bidder is indicating that it is willing to buy any quantity in $\{2, 4\}$ at any price associated with this round. The graph below illustrates how the auction system interprets this all-or-nothing bid:



An all-or-nothing bid is either applied in full or is not applied at all; it is never applied partially. However, unlike a simple bid requesting a reduction, an all-or-nothing bid requesting a reduction will not stop the price if it cannot be applied. This leaves the possibility that the bidder may continue to hold its processed demand from the previous round as the price rises all the way to the current clock price. If the bidder wishes to prevent this, it has the option of associating a “backstop” with an all-or-nothing bid to reduce its demand.

6.2.1 Backstopping

If a bidder submits exactly one all-or-nothing bid for a reduction in quantity for a given product in a given round, the bidder has the option of *backstopping* at a higher price.⁹ This means that, if the price reaches the specified backstop price, the bid may be applied in part (like a simple bid for the same quantity). If there is more than one all-or-nothing bid by a bidder for a given product in the round, backstopping is not permitted.¹⁰

Example: Bidder Places an All-or-Nothing Bid Requesting to Reduce Demand to 2 Blocks at \$5,500 with a Backstop of \$5,700

Suppose that after the bids of the previous round are processed, the bidder’s processed demand for a product is 4 blocks and the posted price is \$5,000. In the current round, the clock price is \$6,000, and the bidder places an all-or-nothing bid requesting to reduce its demand to 2 blocks at price \$5,500 with a backstop at \$5,700.

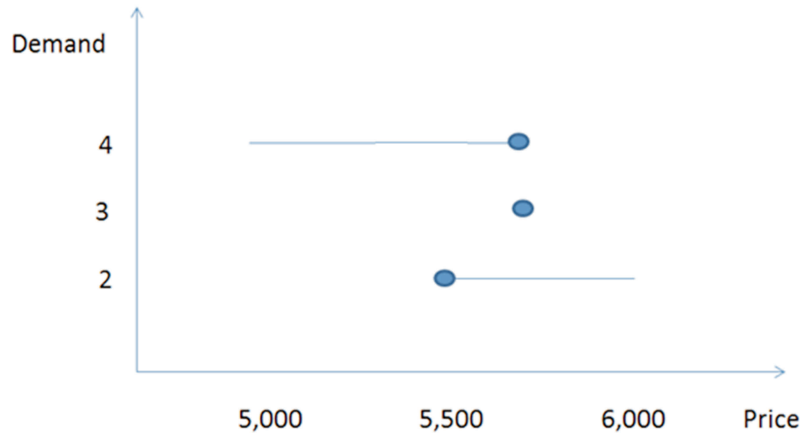
To the auction system, this bid means the following:

- If the price is below \$5,500, the bidder is willing to purchase 4 blocks.
- If the price is between \$5,500 and \$5,700, the bidder is willing to hold either 2 or 4 blocks, but not 3 blocks.
- If the price is exactly \$5,700, the bidder is willing to hold either 2, 3, or 4 blocks.
- If the price is above \$5,700, the bidder is willing to hold only 2 blocks.

⁹ Note that backstopping an all-or-nothing bid at the same price as the all-or-nothing bid is equivalent to submitting a simple bid at that price for the same reduction in quantity.

¹⁰ Permitting bidders to submit multiple all-or-nothing bids for the same product along with one or more backstop prices would significantly complicate the bid processing algorithm and the bidding experience.

The graph below illustrates how the auction system interprets this all-or-nothing bid with a backstop:



This all-or-nothing bid with backstopping is applied as described above, depending on the level of excess demand for the product at \$5,500. However, if the all-or-nothing bid was not applied at \$5,500 and the bidder continues to hold 4 blocks, the backstop indicates that at a price of \$5,700, the bidder would accept a partial reduction in demand if the full bid cannot be applied. Therefore, in the example without the backstop bid, depending on the amount of excess demand, the bidder could have ended the round with processed demand of 4 blocks at the clock price of \$6,000, but with the backstop bid, if the price rose to \$5,700, at least a partial reduction in demand would be applied.

6.3 Switch Bids

A *switch bid* is a request to move demand for up to n blocks in a given PEA from one category to another category. For instance, a bidder can request to switch up to two blocks from Category 1 to Category 2 in a given PEA. Switch bids may be partially applied.

For each switch bid, the bidder specifies two products within the same PEA (a “from” product and a “to” product), a price p for the “from” product, and a quantity q for the “from” category; the bidder does not specify a quantity or a price for the “to” category. In processing the switch bid, the auction system will determine the maximum number of blocks by which demand in the “from” category can be reduced (such that demand does not fall below supply) and will then switch an equal number of blocks to the “to” category.

Such a bid indicates that:

- (1) At all prices that are strictly greater than p and less than or equal to the clock price (or the next price at which the bidder submitted a bid involving the “from” product), the bidder is willing to buy an exact quantity of q of the “from” product;
- (2) At price p , the bidder is willing to buy any quantity between q and its previous demand for the “from” product;¹¹ and

¹¹ The bidder’s previous demand for the “from” product is either equal to its processed demand from the previous round or, if the bidder has placed a switch bid at a price below p involving that product, the quantity in the bid involving that product with the highest price below p .

- (3) The bidder is willing to buy up to a quantity of $d_t + (d_f - q)$ of the “to” product at the clock price, where d_t and d_f denote the bidder’s previous demand for the “to” and “from” products respectively before the switch bid is applied.¹²

Regardless of whether a switch bid for n blocks from product A to product B is fully or partially applied, if the processed demand of the bidder for product A is reduced by m blocks, then the processed demand of the bidder for product B is increased by m blocks, where $1 \leq m \leq n$. A switch bid for 1 block cannot be partially applied.

Example: Bidder Places a Switch Bid for 2 Blocks from Category 1 to Category 2 at \$5,500

Suppose that after the bids of the previous round are processed, the bidder’s processed demand is 4 blocks in Category 1 and 0 blocks in Category 2 in some PEA and the posted price of the Category 1 product in that PEA is \$5,000. In the current round, the clock price for the Category 1 product in that PEA is \$6,000, and the bidder places a single switch bid involving that PEA requesting to switch its demand by 2 blocks from Category 1 to Category 2 at price \$5,500.

To the auction system, this bid means the following:

- If the price of Category 1 is below \$5,500, the bidder is willing to purchase 4 Category 1 blocks.
- If the price of Category 1 is exactly \$5,500, the bidder wishes to switch demand from Category 1 to Category 2 by up to 2 blocks.

Note that the bidder does not specify a quantity or a price for Category 2 blocks in its bid. By placing the bid, the bidder indicates a willingness to purchase up to 2 blocks of Category 2 at the current clock price.

When the auction system processes the bids at price \$5,500, this switch bid will be applied fully, partially, or not at all depending on the level of excess demand at that point in the bid processing:

- If demand exceeds supply by 2 or more blocks in Category 1, the bid is fully applied. The bidder will then hold 2 blocks in Category 1 and 2 blocks in Category 2.
- If demand exceeds supply by only 1 block in Category 1, the bid is partially applied. The bidder then will hold 3 blocks in Category 1 and 1 block in Category 2.
- If demand does not exceed supply, the bid is not applied at all. The bidder will continue to hold 4 blocks in Category 1 and none in Category 2.

In all cases, the bidder’s total processed demand across the categories is still 4. However, a switch bid may be applied partially in the sense that the number of blocks that are switched from Category 1 to Category 2 may be smaller than the maximum number of blocks that the bidder was willing to switch, depending on whether it is possible to reduce the bidder’s demand for Category 1.

7 Processing Bids for a Regular Clock Round

This section describes bid processing in the regular clock rounds. The purpose of bid processing is to determine at the conclusion of a round of bidding, the processed demands for all bidders and the posted prices for all the products. This section provides a definition of *price points* and the details of how bid processing is done in a regular clock round.

¹² The bidder’s previous demand for the “to” product is either equal to its processed demand from the previous round or, if the bidder has placed another switch bid involving that product, the quantity that has already been applied for this product during bid processing at the point this switch bid is considered.

7.1 Missing Bids

For each product for which the bidder had positive processed demand in the previous round, if the bidder did not submit a bid for that product during the current round, it will be deemed to have bid a simple bid for that product with a quantity of 0 at a price equal to the last round's posted price. For example, if the last round's posted price for a particular product is \$6,000 and the bidder does not submit a bid in this round for that product, it will be deemed to have bid a quantity of 0 at \$6,000. Note that this does not necessarily mean that a bidder will receive 0 blocks at \$6,000. The missing bid is processed just as if a bidder submitted a simple bid for 0 blocks at \$6,000. All missing bids are subject to the same checks as those submitted by a bidder.

7.2 Price Points

The *price point* indicates the percentage of the distance between the posted price of the previous round and the clock price of the current round. For example, the 0 percent price point refers to the last round's posted price, the 100 percent price point refers to the clock price, and the 50 percent price point refers to the average of the last round posted price and the clock price of this round. As another example, if the last round's posted price is \$5,000 and the clock price of this round is \$6,000, the price \$5,100 corresponds to the 10 percent price point, and the price \$5,500 corresponds to the 50 percent price point.

7.3 Processed Demands

For processing bids after each round, bids are prioritized in the following order: price point (from lowest to highest) across all bids, and then a bid-specific pseudorandom number (from lowest to highest). The priority ordering of bids remains the same throughout bid processing of a round (that is, only one pseudorandom number is associated with a given bid in a round).

The bid processing algorithm described here maintains a *queue* of all bids from the round that have not been applied in their entirety.¹³ The highest-priority bid that has not yet been considered is processed. The algorithm checks whether the bid is fully acceptable using the most-recently-determined aggregate demand.¹⁴ If the bid is fully acceptable, then it is applied (in its entirety). If the bid is not fully acceptable, then it is placed in the queue. If the bid is a simple bid or a switch bid, then the algorithm checks whether the bid is partially acceptable using the most-recently-determined aggregate demand. If the bid is partially acceptable, then it is partially applied (to the maximum extent possible).

Whenever a bid is applied either partially or in its entirety, the queue is re-tested to determine whether any bids in the queue have become fully acceptable and whether any simple bids or switch bids have become partially acceptable; if so, the highest-priority fully acceptable or partially acceptable bid is applied. When a bid has been applied in its entirety, it is removed from the queue; otherwise, it is kept in the queue so that the remaining part may be applied later. The re-testing of the queue is iterated until no bids remaining in the queue are fully acceptable and no simple or switch bids are partially acceptable. Then the next bid from the round is processed, until (1) all bids from the round have been processed, (2) no bids in the queue are fully acceptable and (3) no simple or switch bids in the queue are partially acceptable. At that point, all bids remaining in the queue are discarded.

The demands of a bidder following the processing of the bids for the round are referred to as its *processed demands*.

¹³ The implementation does not necessarily require a queue, but this description is used here for expository ease.

¹⁴ Note that a bid may be found not acceptable because of insufficient bidding eligibility if another bid submitted by the bidder, requesting a reduction, is not processed due to insufficient aggregate demand, thereby not freeing up bidding units needed to support the requested bid to increase demand for another product. This can occur even when the bidder's activity overall does not exceed its eligibility.

Example 1: Suppose that at the beginning of the round the bidder's processed demand for product A is 4 blocks and the bidder has submitted a simple bid for 0 blocks of product A. If the bid is not fully acceptable (because applying the bid in its entirety would lead to excess supply for product A), but it is possible to apply 1, 2, or 3 blocks of the reduction without creating excess supply for product A, then 3 blocks of the reduction will be applied. The bid for a quantity of 0 blocks for product A will be placed in the queue, so that the remaining one block may be applied later, if conditions permit after other bids have been processed.

If a bidder has backstopped an all-or-nothing bid, the bid processing algorithm uses a simple bid to represent the backstopped price. Therefore, an all-or-nothing bid with backstopping that is not fully acceptable is represented with two bids in the queue: an all-or-nothing bid at the price of the all-or-nothing bid and a simple bid at the backstop price.

Example 2: The bidder's processed demand at the beginning of the round is 4 blocks for product A. There are two other bidders, each with a processed demand of 4 blocks for product A at the beginning of the round. Thus, the aggregate demand for product A at the beginning of the round is 12 blocks. The supply for product A is 10 blocks. The bidder has submitted an all-or-nothing bid to reduce its demand for A to 0 blocks at price \$1,500 and has backstopped that bid at price \$1,700. The bid processing works as follows:

- The all-or-nothing bid is not fully acceptable (because it would lead to excess supply) and it thus placed in the queue.
- The system uses a simple bid for 0 blocks at price \$1,700 to represent the backstopping of the all-or-nothing bid.
- The simple bid is partially acceptable. The maximum extent to which it can be applied is for 2 blocks, since then the aggregate demand is equal to supply for product A. The simple bid is placed in the queue.
- If there are no other bids involving product A, then the bidder's processed demand for product A is 2 blocks when bid processing ends.

Example 3: There are three bidders (bidders 1, 2 and 3), each with a processed demand of 4 blocks for product A at the beginning of the round. Thus, the aggregate demand for product A at the beginning of the round is 12 blocks. The supply for product A is 10 blocks. The following bids are submitted in the round:

- Bidder 1 has submitted an all-or-nothing bid to reduce its demand for A to 0 blocks at price \$1,500 and has backstopped that bid at price \$1,700.
- Bidder 2 has placed a bid to increase its demand to 6 blocks at price \$1,800.

The bid processing works as follows:

- The all-or-nothing bid is not fully acceptable (because it would lead to excess supply) and it is placed in the queue.
- The system uses a simple bid for 0 blocks at price \$1,700 to represent the backstopping of the all-or-nothing bid.
- The simple bid that represents the backstop is considered next. It is partially acceptable. The maximum extent to which it can be applied is for 2 blocks, since then the aggregate demand is equal to supply for product A. The simple bid is placed in the queue. At this point there is no excess demand for product A, and the processed demand of bidder 1 is 2 blocks.
- The bid of bidder 2 is processed, creating 2 units of excess demand for product A. The all-or-nothing bid of bidder 1 is considered, because it is the highest priority bid in the queue (the bid that is associated with the lowest price). The all-or-nothing bid is now fully acceptable, because it is possible to reduce the demand of bidder 1 to 0 blocks. It is applied and removed from the queue. The simple bid representing the backstop is also removed from the queue at this point.
- Bid processing ends and the bidders' processed demands for product A are:
 - o Bidder 1: 0 blocks

- Bidder 2: 6 blocks
- Bidder 3: 4 blocks

If the auction transitions to a new stage, it is possible that for some bidders and some products, the bidder's processed demand at the end of the previous stage is strictly greater than the supply of that product in the new stage. In that case, the bidder's processed demand for that product is set to be equal to the product's supply at the beginning of the first round of the new stage, and the bidder is not allowed to increase its demand for that product because a bidder cannot demand more blocks than are available. However, the bidder maintains its eligibility and can increase its demand for other products.

7.4 Posted Prices

Let $P_{t,r}$ denote the clock price for product r in round t . After the bids of a regular clock round t have been processed, the *posted price* $p_{t,r}$ for product r in round t is set as follows:

- If aggregate demand (evaluated using the processed demands) exceeds supply, the posted price will be set equal to the clock price for the round ($p_{t,r} = P_{t,r}$).
- If aggregate demand (evaluated using the processed demands) is equal to the supply and at least one bid that included a reduction in the quantity demanded of that product was applied (either entirely or partially), the posted price ($p_{t,r}$) will be set to be equal to the product price associated with the bid that has the highest price for product r among all bids from round t that included a reduction in demand for the product and that were applied (either entirely or partially). That is, the *posted price* will be the price at which a reduction caused demand to equal supply.
- If either of the following two conditions holds:
 - The aggregate demand (evaluated using the processed demands) is less than the supply¹⁵
 - The aggregate demand (evaluated using the processed demands) is equal to the supply and no bid that included a reduction in quantity for that product was applied (either as a whole or partially)

Then the posted price will be set to be equal to the posted price of the previous round ($p_{t,r} = p_{t-1,r}$).

These rules ensure that the posted price of a product will not be higher than the price of a simple bid or a switch that requested a reduction for that product and was not applied (either entirely or in part). However, the posted price can be higher than the price of an all-or-nothing that was not applied.

For each all-or-nothing bid with backstopping that was applied either partially or in full, the price p associated with the reduction for the purposes of setting the posted price is set as follows:

- If the all-or-nothing bid was applied (in full), then p is set equal to the all-or-nothing price
- If the all-or-nothing bid was not applied and the backstop was applied partially, then p is set equal to the backstop price

Therefore, in Example 2 of Section 7.3, the posted price is \$1,700. On the other hand, in Example 3 of Section 7.3, the posted price is \$1,500.

8 Checking Closing Conditions and Determining Next Round Type

As part of processing for a round, once bid processing is complete, the auction system must determine what happens next:

¹⁵ For example, because of insufficient demand at opening prices.

- (1) If the last round was a regular clock round and the final stage rule has not previously been met:
 - After bid processing, the auction system will determine if bidding will continue in the current stage and if so whether the next round will be a regular clock round or an extended round. Bidding will not continue in the case where the final stage rule is met and there is no excess demand for any product;
- (2) If the last round was an extended round:
 - After bid processing the auction system will determine if the final stage rule has been met and thus if bidding continues or if the auction moves to a new stage; or
- (3) If the last round was a regular clock round and the final stage rule has previously been met:
 - After bid processing the auction system will determine if the closing conditions for the auction have been met or if bidding will continue with a regular clock round.

This flow is illustrated in Figure 7 below:

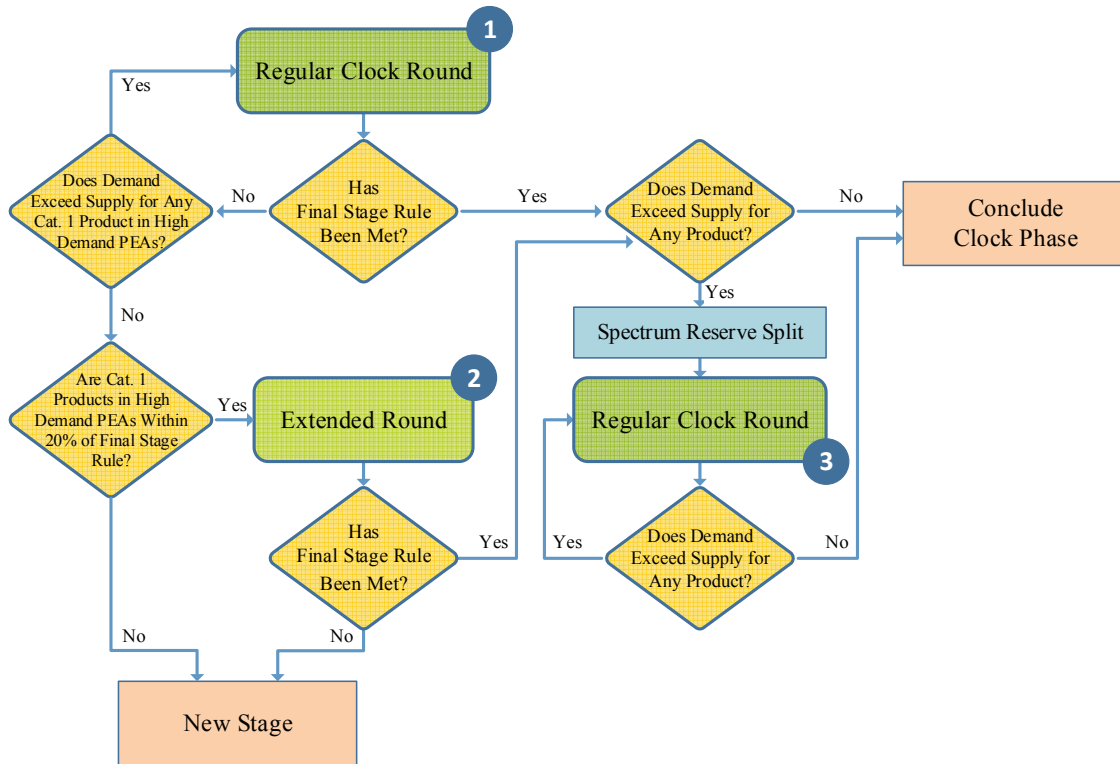


Figure 7: Forward Auction Clock Phase Flow

8.1 Notation

Sections 8.2 and 8.3 use the following notation:

- X is the price per MHz-pop benchmark.
- T is the licensed spectrum benchmark.
- F denotes the set of Category 1 high-demand PEA products.
- N denotes the set of all products.
- p_r is the posted price for product r .
- s_r is the supply (number of blocks) for product r .
- d_r is the aggregate processed demand for product r .
- q_r is the smaller of aggregate processed demand and supply for product r .
- pop_r is the population of the PEA that corresponds to product r .

8.2 Final Stage Rule Calculations

The final stage rule is based on two benchmarks: the price per MHz-pop benchmark X and the licensed spectrum benchmark T (in megahertz). In the *Auction 1000 Procedures PN*, the Commission set X to \$1.25 per MHz-pop and T at 70 megahertz (corresponding to an 84 megahertz clearing target).¹⁶

In each round, after all bids are processed, the current stage will be the final stage if both of the following two components are met:

(1) Average / Aggregate Prices in Forward Auction Component:

- a) For licensed spectrum targets at or below T , the average price per MHz-pop for Category 1 high-demand PEA products is greater than or equal to X .

This clause of the first component of the final stage rule is satisfied if and only if the following inequality holds:

$$\frac{\sum_{r \in F} p_r \cdot q_r}{10 \sum_{r \in F} pop_r \cdot s_r} \geq X$$

OR

- b) For all spectrum clearing targets above T , the current total proceeds of the forward auction is greater than or equal to the product of X , T , and the total number of pops for the high-demand PEAs with at least one Category 1 block in this stage.¹⁷ In particular, this clause of the first component of the final stage rule is satisfied if and only if the following inequality holds:

$$\sum_{r \in N} p_r \cdot q_r \geq X \cdot T \cdot \sum_{r \in F} pop_r$$

Note that the sum on the left hand side includes all products whereas the sum on the right hand side only includes the Category 1 high-demand PEA products.

The sum on the right hand side is the sum of pops across all high-demand PEAs with at least one Category 1 block. If all high-demand PEAs have at least one Category 1 block, then that sum is simply equal to the sum of pops across all high-demand PEAs.

(2) Covering Costs Component:

The net forward auction proceeds, which is the total proceeds adjusted to take into account the discounts for impairments and bidding credits, is sufficient to meet the sum of the following expenses:

- Payments to winning bidders in the reverse auction
- The Commission's administrative costs of the auction

¹⁶ *Broadcast Incentive Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, GN Docket No. 12-268, AU Docket No. 14-252, 30 FCC Rcd 8975, 9078, para. 216 (2015) (*Auction 1000 Bidding Procedures PN*).

¹⁷ This clarifies the description of the calculation for the first component of the Final Stage rule for forward auction stages in which more than 70 megahertz of licensed spectrum is available in the *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9078 para. 216, 9080 para. 220.

- An estimate of broadcaster relocation costs

Let C denote the sum of the aforementioned expenses.

The second component of the final stage rule incorporates both bidding credits and discounts for impairments (see Appendix H for details on impairment discounts), whereas the first component does not. Because winning bidders are not known when the final stage rule is evaluated, bidding credits and impairment discounts are incorporated with a worst case calculation in the second component.¹⁸ In particular, the net revenue of a product will be calculated as the lowest possible revenue that could be expected given the bidders that currently have positive processed demand for that product, their associated bidding credits, and the impairment percentage of each block. This is the revenue that would result if bidders with larger bidding credits were assigned less impaired blocks, and any unsold blocks were the least impaired blocks.

To give specific formulas for the net revenue of product r , taking into account bidding credits and impairment discounts, the following notation is used (in addition to the notation in Section 8.1):

- $d_{i,r}$ is the processed demand of bidder i for product r .
- y_i is equal to 1 minus the bidding credit of bidder i . For example, if bidder i does not qualify for a bidding credit discount, then $y_i = 1$. If bidder i has a 25 percent discount, then $y_i = 0.75$.
- $x_{l,r}$ is equal to 1 minus the impairment percentage for block l of product r . For example, if block l of product r is 10 percent impaired, then $x_{l,r} = 0.9$.

For the purposes of this calculation, if there are unsold blocks the FCC is included as a bidder with processed demand equal to the excess supply and bidding credit equal to 100 percent.

Now consider product r . Bidders with positive processed demand for product r are ordered in increasing order of y_i , or equivalently, in decreasing order of bidding credits. Suppose that there are m such bidders, including the FCC in the case of unsold blocks. Therefore, if there is excess supply, the first bidder corresponds to the FCC.

The blocks of product r are ordered in decreasing order of $x_{l,r}$, or equivalently in increasing order of impairments.

The estimated worst case net revenue from product r is equal to δ_r , where δ_r is defined as follows:

$$\delta_r \equiv p_r \cdot \sum_{i=1}^m y_i \cdot \sum_{l=1+\sum_{k=1}^{i-1} d_{k,r}}^{\min(s_r, \sum_{k=1}^i d_{k,r})} x_{l,r}$$

The second component of the final stage rule is satisfied if:

$$\sum_{r \in N} \delta_r \geq C$$

To explain the formula above, first consider the case that for product r supply is greater than aggregate demand. In this case, the formula assumes that the bidder with the smallest bidding credit (bidder m) gets the $d_{m,r}$ most impaired blocks, the bidder with the second smallest bidding credit (bidder $m - 1$) gets the

¹⁸ Bidder credits are not capped in the calculation of the second component of the final stage rule, because this is a worst case calculation.

$d_{m-1,r}$ next most impaired blocks, etc. Moreover, the formula assumes that the $s_r - d_r$ least impaired blocks are retained by the Commission; in other words, any unsold blocks are the least impaired blocks.

Example: Calculation of worst case net revenue from product with excess supply

Consider a product r with blocks $\{A, B, C, D, E, F\}$, where:

- Block A is 0 percent impaired
- Block B is 5 percent impaired
- Block C is 2 percent impaired
- Block D is 6 percent impaired
- Block E is 10 percent impaired
- Block F is 10 percent impaired

The aggregate demand is $d_r = 4$, and the supply is $s_r = 6$. There is excess supply of 2 blocks. Thus, the FCC is considered as a bidder (bidder 1) with processed demand equal to 2. There are two bidders with positive processed demand for product r : bidder 2 has processed demand $d_{2,r} = 2$ and bidding credit 25 percent, and bidder 3 has processed demand $d_{3,r} = 2$ and bidding credit 0 percent. The posted price is $p_r = 10$. To compute the estimated worst case net revenue from product r , assume that:

- Bidder 1 (the FCC) is assigned blocks A and C
- Bidder 2 is assigned blocks B and D
- Bidder 3 is assigned blocks E and F

That is, $\delta_r = 10 \cdot (1 - 25\%) \cdot (0.95 + 0.94) + 10 \cdot (1 - 0\%) \cdot (0.9 + 0.9) = 32.175$

The worst case assignment is shown in the following table. Note that blocks are listed in increasing order of percent impairment, and bidders are ordered in decreasing order of bidding credits.

Block (impairment)	A (0%)	C (2%)	B (5%)	D (6%)	E (10%)	F (10%)
Bidder (credit)	Bidder 1: FCC (100%)		Bidder 2 (25%)		Bidder 3 (0%)	

In the case that supply of product r is strictly smaller than aggregate demand, then the formula above indicates that the bidder with the largest bidding credit (Bidder 1) gets the $d_{1,r}$ least impaired blocks, the bidder with the second largest bidding credit (Bidder 2) gets the $d_{2,r}$ next least impaired blocks, etc. It stops “assigning” blocks to bidders when there are no more available blocks.

Example: Calculation of worst case net revenue from product with excess demand

Consider a product with supply of 10 blocks. There are 3 bidders each with a processed demand of 4 for that product. Bidder 1 has a bidding credit of 25 percent, Bidder 2 has a bidding credit of 15 percent and Bidder 3 has no bidding credit (*i.e.*, 0 percent). To compute the estimated worst case net revenue from product r , assume that:

- Bidder 1 gets the 4 least impaired blocks
- Bidder 2 gets the 4 next least impaired blocks
- Bidder 3 gets the 2 most impaired blocks

Note that in this example all 10 blocks are assigned, because there is no excess supply.

The calculations for the net revenue will be truncated at the bidder product level to the nearest \$1. In particular, the previous paragraphs explain how to compute δ_r , the estimated worst case net revenue from product r . The calculations will be done in following way. The quantity:

$$p_r \cdot y_i \cdot \sum_{l=1+\sum_{k=1}^{l-1} d_{k,r}}^{\min(s_r, \sum_{k=1}^i d_{k,r})} x_{l,r}$$

is computed for every bidder i and each of these numbers is truncated to the nearest dollar. The summation of these numbers (across all bidders with positive processed demand for the product) will give the worst case net revenue from the product.

If it has been determined that the current stage is final (that is, if the final stage rule was met in a previous round), then the system does not check again whether the final stage rule is satisfied. In particular, the final stage rule calculations are not conducted after the split into reserved and unreserved products.

8.3 Triggering an Extended Round

An extended round is implemented when all of the following conditions hold:

- (i) Aggregate demand does not exceed supply for any Category 1 high-demand PEA products;
- (ii) The final stage rule has not been met;
- (iii) There has been no extended round so far in this stage of the auction; and
- (iv) The minimum extended round increment required to meet the final stage rule (assuming that no bidder reduces its demand in the extended round) is less than or equal to 0.2.¹⁹

If conditions (i)–(iii) above are satisfied, then the auction system checks whether condition (iv) holds. Let g denote this minimum extended round increment required to meet the final stage rule. Then condition (iv) holds if $g \leq 0.2$.

For the purposes of this section, let E denote the set of Category 1 products in the 40 high-demand PEAs for which aggregate processed demand is equal to supply. If conditions (i)–(iv) hold and thus the extended round is implemented, the set of extended round products will be equal to E .

The minimum increment g will be the greater of the minimum extended round increment needed to meet the Average / Aggregate Prices component (z_1) and the minimum extended round increment needed to meet the Covering Costs component of the final stage rule (z_2). Specifically:

$$g \equiv \max\{z_1, z_2\}$$

Where z_1 and z_2 are defined as follows:

- If the Average / Aggregate Prices component is satisfied, then $z_1 = 0$
- If the Average / Aggregate Prices component is not satisfied and the clearing target is at or below T , then

$$z_1 = \frac{X \cdot 10 \sum_{r \in F} pop_r \cdot s_r - \sum_{r \in F \setminus E} p_r \cdot q_r}{\sum_{r \in E} p_r \cdot q_r} - 1$$

¹⁹ Condition (iv) clarifies the description of the same condition in the *Auction 1000 Procedures PN*, 30 FCC Red at 9084, para. 228.

- If the Average / Aggregate Prices component is not satisfied and the clearing target is above T, then

$$z_1 = \frac{X \cdot T \sum_{r \in F} p_r - \sum_{r \in N \setminus E} p_r \cdot q_r}{\sum_{r \in E} p_r \cdot q_r} - 1$$

- If the Covering Costs component is satisfied, then $z_2 = 0$
- If the Covering Costs component is not satisfied, then

$$z_2 = \frac{C - \sum_{r \in N \setminus E} \delta_r}{\sum_{r \in E} \delta_r} - 1$$

(Note that δ_r is the estimated worst case net revenue from product r defined in Section 8.2.)

9 Setting Up the Next Round

If the auction system determines that the closing conditions have not been met in a round, then the system sets up the next round. For each round the system must calculate for each bidder its eligibility for the round based on the activity associated with its processed bids in the previous round. The clock prices for the new round must also be calculated. This section provides the details of these calculations.

9.1 Next Round Eligibility – After a Regular Clock Round

After any regular clock round $t > 1$, the bidder's eligibility for the next round is set to be equal to:

$$\min \left\{ Eligibility(t), \frac{ProcActivity(t)}{ActivityRequirement} \right\}$$

Where:

- $Eligibility(t)$ denotes the bidder's eligibility in round t
- $ProcActivity(t)$ denotes the bidder's *processed activity* from round t , that is, the total number of bidding units associated with the bidder's processed demand after the bid processing of round t . Using the notation of Sections 5.1 and 5.8, $ProcActivity(t) = \sum_{r \in N} d_{t,i,r} \cdot b_r$
- $ActivityRequirement$ denotes the activity requirement. This is a percentage (up to 100 percent) set by the Commission.

9.2 Next Round Eligibility – After an Extended Round

If an extended round was triggered in stage $u - 1$ and the final stage rule was not met during the extended round, then the auction proceeds to stage u . In this case, the round after the extended round of stage $u - 1$ is round 1 of stage u , and the eligibility of bidder i in round 1 of stage $u > 1$ is set to be equal to:

$$\sum_{r \in ER} d_{i,r} \cdot b_r + \frac{1}{ActivityRequirement} \sum_{r \notin ER} d_{i,r} \cdot b_r$$

Where:

- $d_{i,r}$ denotes the processed demand of bidder i for product r after the extended round of stage $u - 1$ (for products that are not part of the extended round, this is just the processed demand after the last round before the extended round)
- b_r denotes the number of bidding units associated with product r .

- ER denotes the set of extended round products (see Section 3.2).

9.3 Clock Prices for Regular Round

Once the posted prices for a round are calculated and the system has determined that the next round will be a regular clock round, the clock price for each product in the round is calculated as the product's posted price from the previous round multiplied by an increment.

Specifically, the clock price $P_{t,r}$ for product r in round t is calculated as:

$$P_{t,r} = (p_{t-1,r}) \cdot (1 + y)$$

rounded up to the nearest \$1,000.

Where:

- y denotes the price increment for round t .
- $p_{t-1,r}$ denotes the posted price for product r after round $t - 1$.

Note that this calculation applies to every product, irrespective of whether the product is in excess demand.

9.4 Clock Prices for Extended Round

If the auction system has determined that the next round will be an extended round, the system will calculate the clock price for each product in the extended round. Similar to a regular round, the clock price for a product in an extended round is calculated as the product's posted price from the previous round multiplied by an increment. However, the price increment in an extended round is set so that the price increase is some amount greater than the amount needed to reach the final stage rule. In the *Auction 1000 Procedures* PN, the Commission set this amount to be 33 percent greater than the amount needed.²⁰ The same percentage of price increase will be applied to all products that are part of the extended round.

The increment for the extended round will be set to be equal to:

$$y \equiv 1.33 \cdot g$$

Where g is the minimum extended round increment required to meet the final stage rule assuming that no bidder reduces its demand in the extended round.²¹

10 Processing Bids for an Extended Round

10.1 Special Bidding Rules

In an extended round, a bidder can only bid on extended round products,²² and will be permitted to accept the clock price for the blocks it demands or to submit an intra-round bid that requests a reduction of one block at a price less than or equal to the clock price and greater than or equal to the last round posted price. Only bidders with positive processed demands for extended round products from the previous round will be permitted to bid in the extended round.

²⁰ *Auction 1000 Procedures* PN, 30 FCC Rcd at 8084–85, para. 231.

²¹ See Section 8.3 for how g is calculated.

²² See Section 3.2 for the definition of extended round products.

10.2 Missing Bids

For extended round products, if the bidder has positive processed demand after the bid processing of the previous round and it does not submit a bid during the extended round for that product, it will be deemed to have submitted a bid to reduce its demand by 1 unit at a price equal to the last round's posted price for that product.

10.3 Processing Bids

Bids are processed sequentially in the following order: price point (from lowest to highest) across all bids,²³ and then a bid-specific pseudorandom number (from lowest to highest). At the lowest price p at which the auction system encounters a bid for a product r , the uniform price applying to that product will stop increasing and will be equal to p . The prices of products for which no bid has been processed so far continue increasing. During the extended round, processing ends if, at any time, the final stage rule is met given the current prices and the processed demand at the beginning of the round. The prices at which the final stage rule is met do not necessarily correspond to a price point with a bid.

For purposes of calculating whether the final stage rule is met, non-ER products are factored in using the aggregate demand and the posted prices from the previous round.

If the final stage rule is met, the prices at which the final stage rule is met are called the *extended round clearing prices*.

If the final stage rule is not met, the prices that arise after having processed all bids of the extended round are called the *extended round processed prices*. In particular, for a product for which a reduction bid was processed during the extended round, the extended round processed price is equal to the price of the bid associated with the reduction. For a product for which there was no reduction bid during the extended round, the extended round processed price is equal to its clock price.

Example 1: There are three products (A, B, and C). For all three products, in the extended round the last round's posted price is \$1,000 and the clock price is \$1,200. There is a bid to reduce demand for product A by one at price \$1,050 (*i.e.*, the 25 percent price point), and a bid to reduce demand for product B by one at price \$1,150 (*i.e.*, the 75 percent price point). There is no reduction bid for product C. If 50 percent is the lowest price point at which the final stage rule is met, then the extended round clearing prices are: \$1,050 for product A, \$1,100 for product B and \$1,100 for product C (corresponding to the 50 percent price point). If the final stage rule is not met during the extended round, then the extended round processed prices are \$1,050 for product A, \$1,150 for product B, and \$1,200 for product C.

If the final stage rule is met during the extended round, then:

- The processed demand of each bidder is set to be equal to its processed demand at the start of the extended round (reductions in demand are not applied)
- For every ER product, the posted price is set to be equal to its extended round clearing price
- For every non-ER product, the posted price for the extended round is equal to the posted price of the previous round
- If there is still excess demand for any products, the market-based spectrum reserve is applied for Category 1 products and the forward auction is run until completion after the extended round. In this case, in every round after the extended round, bidding will be open on all products (including the Category 1 high-demand PEA products).

If, after the bid processing of the extended round, the final stage rule is not met, a new stage commences and the reductions of bids that were processed during the extended round are applied and carry over to the first round of the next stage. Note that this means that for a given product, only one bidder's demand

²³ See Section 5.1 for the definition of price point.

reduction will be processed and thus carried over to the next round. If multiple bidders bid for a reduction at the same price for the same product, the determination of which bidder's reduction is accepted is based on pseudorandom numbers. For an *ER* product, the posted price is set to be equal to its extended round processed price. For non-*ER* products, the posted price is equal to the posted price of the last regular round before the extended round.

Example 2: In the extended round, for product A, the clock price is \$1,200 and the last round posted price is \$1,000. At the beginning of the extended round, the processed demand of bidder 1 for product A is 2 blocks and the processed demand of bidder 2 for product A is 3 blocks. Bidder 1 had submitted a bid to reduce its demand by one at price \$1,050 and bidder 2 had submitted a bid to reduce its demand by one at price \$1,075. Bidder 2's bid can never be applied, because demand cannot fall by more than one unit in the extended round. Suppose that bidder 1's bid is processed. Then, the price of product A will stop increasing, so the posted price for product A in the extended round will be \$1,050. If the final stage rule is met during the extended round, then the processed demand of bidder 1 will be 2 blocks and the processed demand of bidder 2 will be 3 blocks. If the final stage rule is not met during the extended round, then the processed demand of bidder 1 for product A is 1 block, the processed demand of bidder 2 will be 3 blocks, and the auction proceeds to a new stage.

11 Reserve Spectrum Split

The *spectrum reserve trigger* occurs if after a round, the final stage rule is met and there is still excess demand for at least one product. If at least one reserve-eligible bidder in a PEA has positive processed demand for the Category 1 product of that PEA when the spectrum reserve is triggered, that product is separated in two products: reserved and unreserved. A bidder can bid on both the reserved product and the unreserved product if it is reserve-eligible for that PEA. Bidders that are not reserve-eligible for the PEA can only bid on the unreserved product.

11.1 Maximum reserved spectrum amounts

Let $M_{u,j}$ denote the maximum number of blocks of reserved spectrum for stage u in PEA j . The following table is used to determine $M_{1,j}$ for every PEA j :

Licensed Spectrum In the Initial Clearing Target (in megahertz)	100*	90	80	70	60	50	40
Minimum Unreserved Spectrum	70	60	50	40	40	40	30
Maximum Reserved Spectrum	30	30	30	30	20	10	10

*The maximum amount of reserved licensed spectrum is 30 megahertz for initial clearing targets with more than 100 megahertz of licensed spectrum.

Given the amount of total spectrum in a PEA (*i.e.*, both Category 1 and Category 2) in stage 1, the first line is used to determine the correct column. Then, the last line of that column gives the maximum amount of reserved spectrum in that PEA in stage 1. Recall that 10 megahertz corresponds to one block. For example, according to the table above:

- If in some PEA j there are 9 blocks offered in stage 1 of the auction, then $M_{1,j} = 3$, *i.e.*, at most 3 of the Category 1 blocks in that PEA can become reserved in stage 1.
- If in some PEA j there are 6 blocks offered in stage 1 of the auction, then $M_{1,j} = 2$, *i.e.*, at most 2 of the Category 1 blocks in that PEA can become reserved in stage 1.

If the total spectrum in a PEA is less than 40 megahertz, then the maximum amount of reserved spectrum in that PEA in stage 1 is set to be equal to 0, that is, $M_{1,j} = 0$.

In later stages of the forward auction, the maximum number of blocks that can become reserved in a given PEA will generally be equal to the smaller of (1) the maximum amount in the previous stage, and (2) the total processed demand of reserve-eligible bidders for the Category 1 product in that PEA at the end of the previous stage – unless the supply in the previous stage for Category 1 in that PEA was 0 or 1 blocks. Specifically, in stage $u > 1$, the maximum number of blocks of reserved spectrum for PEA j , $M_{u,j}$, is set as follows:

- If $s_{u-1,j} = 0$, then $M_{u,j} = M_{u-1,j}$
- If $s_{u-1,j} = 1$ and $d_{u-1,j} > 0$, then $M_{u,j} = M_{u-1,j}$
- In all other cases, $M_{u,j} = \min(M_{u-1,j}, d_{u-1,j})$

where $d_{u-1,j}$ denotes the total processed demand for Category 1 in PEA j across reserve-eligible bidders at the end of stage $u - 1$, and $s_{u-1,j}$ denotes the supply for Category 1 in PEA j in stage $u - 1$.

11.2 Supply of reserved and unreserved products

If the spectrum reserve is triggered in stage u , the supply for each reserved product in PEA j is set to be equal to the minimum of (1) the quantity demanded for the product by reserve-eligible bidders for that PEA at the time the spectrum reserve is triggered, (2) the maximum number of blocks that can become reserved in PEA j and stage u , and (3) the supply of the pre-split product. Moreover, if there is only one reserve-eligible bidder with positive processed demand for the pre-split Category 1 product in a PEA, then the supply of the reserved product is capped at 2.

To give a formula for how to calculate the supply of the reserved product at the split, the following notation is used:

- D denotes the total processed demand across all reserve-eligible bidders for Category 1 in PEA j at the time of the split.
- k denotes the number of reserve-eligible bidders with positive processed demand for Category 1 in PEA j at the time of the split.
- $s_{u,j}$ denotes the supply in stage u for Category 1 in PEA j .

If the final stage rule is met in stage u , then the supply of the reserved product in PEA j is set equal to:

- $\min(D, M_{u,j}, s_{u,j})$, if $k > 1$
- $\min(D, 2, M_{u,j}, s_{u,j})$, if $k = 1$
- 0, if $k = 0$

Example: The final stage rule is met in stage u . In stage u , there are six Category 1 blocks and two Category 2 blocks in PEA j , and $M_{u,j} = 3$. One reserve-eligible bidder has processed demand equal to 4 for Category 1 of PEA j at the time of the split, and all other reserve-eligible bidders have processed demand equal to 0 for that product. Then the supply of the reserved product in PEA j is equal to 2.

The supply for an unreserved product is equal to the difference between the supply of the corresponding pre-split product and the supply of the corresponding reserved product. Reserved and unreserved products will be considered as separate products for the purpose of setting clock and posted prices and checking whether a bid is partially or fully acceptable.

11.3 Distributing Demand at the Split (between Reserved and Unreserved)

Until the reserve is triggered, all bidders for Category 1 blocks, whether reserve-eligible or not, will be bidding on a single category (*i.e.*, Category 1). Right after the reserve is triggered, the processed demand

for the pre-split (Category 1) product is distributed between the reserved and unreserved product according to the following algorithm:

- (1) All demand of bidders that are not reserve-eligible is assigned to the unreserved product.
- (2) A pseudo-random number is assigned (by product) to each reserve-eligible bidder with positive processed demand for the pre-split product.
- (3) Starting with the bidder with the highest number, assign one unit of its processed demand to the reserved product, proceeding with the next highest number until demand equals supply for the reserved product. In this step, the algorithm may re-cycle across reserve-eligible bidders if demand is less than supply for the reserved product at the time that each reserve-eligible bidder has been assigned one block of the reserved product.
- (4) Once the processed demand for the reserved product is determined for all reserve-eligible bidders in that PEA, the processed demand of a reserve-eligible bidder for the unreserved product is set to be equal to the difference between the bidder's processed demand for the pre-split product and the bidder's processed demand for the reserved product (which is determined by step (3) above).
- (5) If at this point a bidder's processed demand for the unreserved product exceeds the supply of the unreserved product, then the bidder's processed demand for this product is set to be equal to its supply. The bidder will then not be allowed to increase its demand for that unreserved product because a bidder cannot demand more blocks than are available. However, the bidder will maintain its eligibility and can increase its demand for other products.

Note that:

- The processed demand for the unreserved product of a bidder that is not reserve-eligible in that PEA is equal to the minimum of its processed demand for the pre-split product and the supply of the unreserved product.
- The processed demand for the reserved product of a bidder that is not reserve-eligible in that PEA is equal to 0 (since the bidder cannot bid on that product).
- If the supply of the reserved product is equal to the total of all reserve-eligible bidders' processed demands for the pre-split product in that PEA, then right after the split the processed demand of each reserve-eligible bidder in that PEA for the reserved product is equal to its processed demand for the pre-split product.
- If the supply of the reserved product is strictly smaller than the total of all reserve-eligible bidders' processed demands for the pre-split product in that PEA, then the supply of the reserved product is distributed evenly among reserve-eligible bidders, while avoiding excess supply of both the reserved and the unreserved product (unless there is excess supply for the pre-split product).

Example:

Suppose there are two reserve-eligible bidders each with a processed demand of 2 blocks for the pre-split product.

- If the supply of the reserved product is 2 blocks, then right after the split:
 - o The processed demand of each reserve-eligible bidder is equal to 1 block for the reserved product and 1 block for the unreserved product.
- If the supply of the reserved product is 3 blocks, then right after the split:²⁴
 - o The processed demand of one reserve-eligible bidder (the bidder with the larger pseudo-random number) is equal to 2 blocks for the reserved product and 0 blocks for the unreserved product

²⁴ In this case, the algorithm will proceed by first assigning one block of reserved to each bidder, and then assigning a second block of reserved to the bidder with the larger pseudorandom number.

- The processed demand of the other reserve-eligible bidder is equal to 1 block for the reserved product and 1 block for the unreserved product
- If the supply of the reserved product is 1 block, then right after the split:
 - The processed demand of one reserve-eligible bidder (the one with the larger pseudo-random number) is equal to 1 block for the reserved product and 1 block for the unreserved product
 - The processed demand of the other reserve-eligible bidder is equal to 2 blocks for the unreserved product (and 0 blocks for the reserved product)

APPENDIX H

Forward Auction Assignment Phase and Post-Auction License Prices

1 Introduction

This appendix provides a final version of Appendix H of the *Auction 1000 Comment PN* detailing the second part of the forward auction procedure adopted by the Commission in the *Auction 1000 Bidding Procedures PN*: the assignment phase. The assignment phase is designed to promote two major goals. One of these is to make bidding relatively easy in what is an inherently complex allocation problem. The procedure the Commission adopted promotes simplicity in several ways. First, to reduce the total number of bids that each bidder must make, it groups together PEAs with identical clock phase winners and winnings and which do not have any impaired blocks. Second, to simplify bidding strategy for bidders, it adopts a *second-price* type of pricing rule that encourages bidders to bid according to their actual values for different blocks. Third, a winner does not need to make any additional bids – or make any additional payments – in the assignment phase. This makes bidding easier not only in the assignment phase of the forward auction but in the clock phase as well, because bidders in the clock phase will know that they need not pay more for licenses than the prices bid in the clock phase.

A second, equally important goal is to promote efficient and intensive use of the spectrum. To achieve that, the assignment phase rules give highest priority to assigning to the extent possible a set of contiguous frequencies to each bidder within each PEA.

2 Assignment Rounds

The assignment phase consists of a series of *assignment rounds*. In each assignment round, licenses are assigned in up to six *assignment phase markets*, with each assignment phase market consisting of either a single PEA or a group of PEAs; see Section 2.1. Winning bidders from the clock phase that have a preference for specific license frequencies submit sealed bids for those licenses; see Section 2.2. Once an assignment round concludes, an optimization is solved to assign specific frequency licenses to each winning bidder from the clock phase.

For the purposes of the assignment phase, the reserved and the unreserved spectrum will be considered one product. Thus, there are at most two products in each PEA, a Category 1 product and Category 2 product, each potentially with multiple blocks. However, since final clock phase prices may be different for reserved and unreserved blocks in a PEA, those different prices will be reflected in the final payments, as described in Section 7.4.

The auction system will determine whether to group PEAs into a single assignment phase market according to the rule detailed in Section 2.1 below.

2.1 Grouping PEAs into a Single Assignment Phase Market

A set of PEAs P will be “grouped” into one *assignment phase market* if all of the following three conditions are met:

1. The PEAs in P are one of the following:
 - a) All high-demand, regardless of Regional Economic Area Grouping (“REAG”);¹ or
 - b) All in the same REAG and not subject to the small market bidding credit cap;² or
 - c) All in the same REAG and subject to the small market bidding credit cap;
2. Each PEA in P has the same number of blocks, all of which are Category 1 blocks and have zero percent impairment; and
3. Each PEA in P has identical clock phase winners and winnings.³

Because of this grouping of PEAs, the number of assignment phase markets will be smaller than or equal to the number of PEAs.

Example 1: High-Demand Grouping

A	B	3	37	3	C	D	E	F	G	H
---	---	---	----	---	---	---	---	---	---	---

Suppose the final band plan is the 108 megahertz plan with blocks A-H and suppose that PEA-003 and PEA-025 are both “high-demand”. Additionally, in each of these PEAs:

- All eight frequency specific licenses are 0 percent impaired (and therefore Category 1).
- Bidder #1 won four Category 1 blocks in the clock phase.
- Bidder #2 won two Category 1 blocks in the clock phase.
- Bidder #3 won two Category 1 blocks in the clock phase.

Then PEA-003 and PEA-025 will be grouped and treated as a single combined market for the assignment phase.

Example 2: REAG Grouping

A	B	3	37	3	C	D	E	F	G	H
---	---	---	----	---	---	---	---	---	---	---

In this example, the final band plan is also 108 megahertz (*i.e.*, blocks A-H). Suppose that PEA-060, PEA-069, and PEA-077 are all in REAG 1 and are not “high-demand” PEAs. Note that none of these PEAs are subject to the small market bidding credit cap.

¹ High-demand markets are PEAs 1–40. See *Broadcast Incentive Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, GN Docket No. 12-268, AU Docket No. 14-252, 30 FCC Rcd 8975, 9079, para. 218 n.647 (2015) (*Auction 1000 Bidding Procedures PN*). The six Regional Economic Area Groupings (REAG) are: Northeast, Southeast, Great Lakes, Mississippi Valley, Central, and West. Each of the remaining REAGs (*i.e.*, Alaska, Hawaii, Puerto Rico and US Virgin Islands, Guam and the Northern Mariana Islands, American Samoa, and the Gulf of Mexico) will be merged in one of the 6 main REAGs.

² Markets that are subject to the small market bidding credit cap are those PEAs with a population of 500,000 or less, which corresponds to PEAs 118–416, excluding PEA 412. *Updating Part 1 Competitive Bidding Rules*, WT Docket No. 14-170, GN Docket No. 12-268, Report and Order, 30 FCC Rcd 7493, 7546, para. 127 (“[N]o winning DE bidder will be able to obtain more than \$10 million in bidding credits for licenses won in PEAs 118–416, with the exception of PEA 412 (Puerto Rico), which exceeds the 500,000 pop threshold.”) (*Part 1 R&O*).

³ For example, in all PEAs in the group there are five Category 1 blocks with zero percent impairment. Bidder A won one block in each of the PEAs in the group. Bidder B won one block in each of the PEAs, and Bidder C won three blocks in each of the PEAs.

In each of these PEAs:

- All eight frequency specific licenses are 0 percent impaired (and therefore Category 1).
- Bidder #1 won four Category 1 blocks in the clock phase.
- Bidder #2 won two Category 1 blocks in the clock phase.
- Two Category 1 blocks were unsold in the clock phase.

Then PEA-060, PEA-069, and PEA-077 will be grouped and treated as a single combined market for the assignment phase.

Example 3: Not Possible to Group

A	B	3	37	3	C	D	E	F	G	H
---	---	---	----	---	---	---	---	---	---	---

Finally, suppose once again that the final band plan is the 108 megahertz plan and that PEA-043 and PEA-045 are both in REAG 2 and are not “high-demand” PEAs. In each of these PEAs, all eight frequency specific licenses are 0 percent impaired (and therefore Category 1). However, the winners in these two PEAs are as follows:

In PEA-043:

- Bidder #1 won four Category 1 blocks in the clock phase.
- Bidder #2 won two Category 1 blocks in the clock phase.
- Bidder #3 won two Category 1 blocks in the clock phase.

In PEA-045:

- Bidder #1 won four Category 1 blocks in the clock phase.
- Bidder #2 won two Category 1 blocks in the clock phase.
- Bidder #4 won two Category 1 blocks in the clock phase.

Then, PEA-043 and PEA-045 will not be grouped, because they do not have identical clock phase winners.

2.2 Sequencing of Assignment Rounds

The assignment phase begins with assignment rounds for high-demand PEAs. Assignment phase markets that include high-demand PEAs are ordered in descending order of weighted-pops, and bidding is conducted for a single assignment phase market per round, sequentially.

After bidding has been conducted for the “high-demand” PEAs, bidding is conducted simultaneously for the six REAGs, but in descending order of weighted-pops within each REAG. That is, bidding may be conducted for up to six assignment phase markets at the same time, in order to speed up the assignment phase. The rounds continue until all assignment phase markets are assigned.

If an assignment phase market consists of multiple PEAs, its weighted-pops will be set to be equal to the sum of the weighted-pops of the PEAs that it comprises, for purposes of determining the sequencing.

Before bidding for the assignment phase starts, the auction system will inform bidders about which PEAs have been grouped and the sequencing of assignment rounds.

The following tables show two examples of the sequencing of assignment phase markets. In the first example, there is no grouping, that is, each assignment phase market consists of a single PEA. In the second example, some assignment phase markets consist of multiple PEAs and, as a result, there are fewer assignment rounds.

Round	PEA (State)					
1	001 (NY)					
2	002 (CA)					
...	...					
40	040 (AL)					
	REAG 1	REAG 2	REAG 3	REAG 4	REAG 5	REAG 6
41	041 (NY)	043 (NC)	052 (WV)	046 (AR)	047 (TX)	042 (HI)
42	044 (NY)	045 (NC)	056 (MI)	051 (KY)	053 (AZ)	070 (OR)
43	048 (PA)	050 (SC)	058 (IN)	055 (AL)	063 (OK)	076 (NV)
...

Table 1: Sequencing of assignment phase markets with no grouping.

Round	PEA(s)					
1	001; 002; 015					
2	003; 025					
...	...					
31	040					
	REAG 1	REAG 2	REAG 3	REAG 4	REAG 5	REAG 6
32	041; 044	043	052	046	047	042
33	048	045	056	051; 055	053	070
34	060; 069; 077	050	058	059	063	076
...

Table 2: Sequencing of assignment phase markets with grouping.

As illustrated in the tables above, after bidding for the “high-demand” PEAs is finished, bidding for multiple assignment phase markets will be conducted in the same round.⁴

3 Assignment Phase Efficiency Objectives

Because it may not be possible to guarantee contiguous assignments to all bidders within a market, assignments will attempt to satisfy the following objectives in a given market:

- (1) Maximize the number of bidders that are assigned at least two contiguous spectrum blocks.
- (2) Minimize the total number of stranded blocks across all bidders. Block j is *stranded* for bidder i if (i) bidder i won two or more blocks in the clock phase for that market, (ii) bidder i is assigned block j , and (iii) block j is not contiguous with any of the bidder’s other assigned blocks in the market.
- (3) Maximize the number of bidders whose assigned blocks in a market are all contiguous with one another.

⁴ The *Auction 1000 Bidding Procedures PN* refers to grouping together PEAs in a single assignment round and then running up to six assignment rounds in parallel, thus implying that a round is conducted for each assignment phase market. *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9087–88, paras. 242–43. However, in the auction system, a round refers to a timing round, thus bidding for multiple assignment phase markets may be conducted in parallel within a single round, as shown in Tables 1 and 2 above.

- (4) Maximize the number of pairs of unsold blocks that are contiguous, but only to the extent that the level of impairment of blocks assigned to bidders does not increase.

These objectives will be optimized lexicographically in the order that they are given. In particular, Step 1 is to maximize the number of bidders that are assigned at least two contiguous blocks. Step 2 is to minimize the number of stranded blocks among all allocations that optimize the first objective. Step 3 is to maximize the number of bidders whose blocks in a market are all contiguous with one another among all allocations that optimize the objectives of Step 1 and Step 2.

Step 4 is to maximize the number of pairs of unsold blocks that are contiguous subject to the constraint that the sum of impairments of unsold blocks is maximized among all allocations that optimize the objectives of Steps 1, 2, and 3. In other words, Step 4 limits assignments to those that maximize the contiguity of unsold spectrum (*i.e.*, the blocks that are retained by the FCC) subject to the constraint of not increasing the impairment of blocks that will be assigned to bidders.

The fourth objective aims to maximize the number of pairs of unsold blocks that are contiguous. For example, if there are exactly two unsold blocks, then this objective aims to have the two unsold blocks be contiguous. As another example, consider the case where there are four unsold blocks in a market: if the four unsold blocks are contiguous spectrum, then there will be three pairs of contiguous unsold blocks; this will be preferred to having two separate contiguous pairs.

The objectives of assigning contiguous blocks apply across categories. For instance, if a bidder won one Category 1 block and one Category 2 block in a market, the first objective will attempt to assign to that bidder a Category 1 block and a Category 2 block that are contiguous.

3.1 Examples

Example 1: Contiguity in 108 Megahertz Clearing

In this example, the final band plan is the 108 megahertz plan. As a result, two blocks (A and B) will be located below Channel 37, and six blocks (C through H) will be located above Channel 37. Thus, the available blocks in a PEA where all eight blocks are in Category 1 would be as follows:

A	B	3	37	3	C	D	E	F	G	H
---	---	---	----	---	---	---	---	---	---	---

If there are two winners from the clock phase and each has won four blocks, it will not be possible to give each bidder four contiguous blocks. The auction system will be able to fully satisfy the first objective (to give each bidder at least two contiguous blocks) and the second objective (to prevent any assignments that strand single blocks). However, the third objective cannot be fully satisfied (to assign both bidders all contiguous blocks) due to the presence of Channel 37. Thus, the possible assignments are that one bidder would be assigned blocks ABCD and the other blocks EFGH, or that one bidder would be assigned blocks ABGH and the other blocks CDEF:

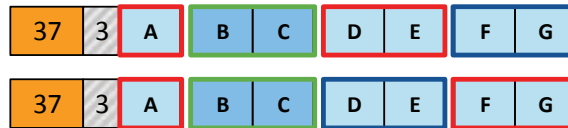
A	B	3	37	3	C	D	E	F	G	H
A	B	3	37	3	C	D	E	F	G	H

Example 2: Contiguity in 84 Megahertz Clearing

In this example, the final band plan is the 84 megahertz plan. Here, all blocks (A through G) will be located above Channel 37. However, suppose that in a PEA, two blocks (B and C) are Category 2, while the rest are Category 1 blocks. The available blocks in the PEA would be as follows:

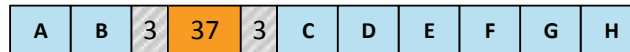
37	3	A	B	C	D	E	F	G
----	---	---	---	---	---	---	---	---

If there are three winners from the clock phase, where one bidder has won three Category 1 blocks, one bidder has won two Category 1 blocks, and one bidder has won two Category 2 blocks, it will not be possible to assign each bidder all contiguous blocks. The first objective (to assign at least two contiguous blocks to every bidder that won at least two blocks in the clock phase) can be satisfied in full, but the second objective cannot be fully satisfied because the bidder that won three Category 1 blocks can only be assigned a set of blocks that includes the stranded A block. Thus, the bidder that won three Category 1 blocks could be assigned either blocks ADE or AFG, the bidder that won two Category 1 blocks could be assigned either blocks FG or blocks DE, and the bidder that won two Category 2 blocks could only be assigned blocks BC:



Example 3: Contiguity in 108 Megahertz Clearing with Undersell

In this example, the final band plan is the 108 megahertz plan. As a result, two blocks (A and B) will be located below Channel 37, and six blocks (C through H) will be located above Channel 37. Thus, the available blocks in a PEA where all eight blocks are in Category 1 would be as follows:



Each of three bidders has won two Category 1 blocks in the clock phase. It is thus possible to assign contiguous spectrum to all bidders.

Suppose in a particular PEA there are two unsold blocks. The license corresponding to block A is 10 percent impaired and the license corresponding to block B is 5 percent impaired. Consider two cases:

- Case 1: The licenses corresponding to blocks C through H are 0 percent impaired each. To maximize the sum of impairments across unsold blocks subject to the constraint that all three bidders get contiguous spectrum, the licenses corresponding to blocks A and B would be designated as unsold; the maximum sum is then 15 percent. In this case, it is possible to have contiguous unsold blocks when the sum of impairments across unsold blocks is the maximum possible (*i.e.*, 15 percent).
- Case 2: The license corresponding to block E is 8 percent impaired, the license corresponding to block H is 12 percent impaired, and the remaining licenses (*i.e.*, C, D, F and G) are 0 percent impaired each. To maximize the sum of impairments across unsold blocks subject to the constraint that all three bidders get contiguous spectrum, the auction system would designate the licenses corresponding to blocks E and H as unsold; the maximum sum is then 20 percent.⁵ In this case, it is not possible to have contiguous unsold blocks when the sum of impairments across unsold blocks is the maximum possible (*i.e.*, 20 percent).

3.2 Mathematical Formulation of Steps 1, 2, 3, and 4

In the mathematical formulations below, the index i is used to denote a bidder and the index j is used to denote a specific frequency block. Moreover, the following notation is used:

- N denotes the set of bidders in that assignment phase market, that is, the set of winners from the clock phase.

⁵ If blocks A and H were designated as unsold, the sum of impairments would be 22 percent (*i.e.*, larger than 20 percent), but it would not be possible to assign contiguous spectrum to all three bidders.

- N_2 denotes the set of bidders in that assignment phase market that have won at least two blocks in that assignment phase market, considering both categories.
- The FCC is referred to as bidder 0. $N \cup \{0\}$ is used to denote the set of bidders and the FCC. Similarly, $N_2 \cup \{0\}$ is also used.
- K denotes the set of blocks that were available for sale in that market. For instance, K may be $\{A, B, C, D, E, F, G, H\}$ or $\{A, C, D, E, F, G, H\}$. The latter could represent a case where block B was not auctioned at all (in that market) because it was too impaired.
- K_1 denotes the set of blocks in Category 1
- K_2 denotes the set of blocks in Category 2
- d_j denotes the percentage of impairment of block j
- $q_{i,1}$ denotes the number of blocks in Category 1 that bidder i has won in that assignment phase market.
- $q_{i,2}$ denotes the number of blocks in Category 2 that bidder i has won in that assignment phase market.
- q_i denotes the total number of blocks that bidder i has won in that assignment phase market. That is, $q_i = q_{i,1} + q_{i,2}$.
- C denotes the set of pairs of blocks that are contiguous in that assignment phase market. In particular, $(j, k) \in C$ if and only if blocks j and k are contiguous.
- The notation $j + 1$ is used to represent the block right after block j in K . For example, if $K = \{A, B, C, D, E, F, G, H\}$, then $A+1$ denotes block B, $E+1$ denotes block F, and $G+1$ denotes block H. On the other hand, if $K = \{A, B, C, D, E, G, H\}$, then $A+1$ denotes block B, $E+1$ denotes block G, and $G+1$ denotes block H.
- The set Φ is defined as follows: $\Phi \equiv \{j \in K: (j, j+1) \in C\}$. That is, a block j is in the set Φ if blocks j and $j+1$ are contiguous. For example, in the 108 megahertz plan with all eight blocks available for sale, $K = \{A, B, C, D, E, F, G, H\}$ and $\Phi = \{A, C, D, E, F, G\}$. On the other hand, in the 108 megahertz plan with $K = \{A, B, C, D, E, G, H\}$ (that is, block F is not available for sale), $\Phi = \{A, C, D, G\}$. Blocks B and C are not contiguous in the 108 megahertz plan because of channel 37.

Variable Definitions:

- $x_{i,j}$ is a binary decision variable which has a value of 1 if bidder i is assigned block j and 0 otherwise. This variable is defined for all $i \in N \cup \{0\}$ and all blocks $j \in K$. Note that $x_{0,j} = 1$ if block j is assigned to the FCC (and thus is not assigned to any bidder) and $x_{0,j} = 0$ otherwise.
- z_i is a binary decision variable which at the optimal solution has a value of 1 if bidder i is assigned at least two contiguous blocks and 0 otherwise. This variable is defined only for bidders $i \in N_2$, that is, for bidders that won at least two blocks in the clock phase in that market.
- $t_{i,j}$ is a binary decision variable which is used for setting the right value for variable z_i . Variable $t_{i,j}$ is equal to zero when bidder i is not assigned both blocks j and $j+1$. If bidder i is assigned both blocks j and $j+1$, then $t_{i,j}$ is just constrained to be in $\{0,1\}$. This variable is defined for all $i \in N_2 \cup \{0\}$ and all blocks $j \in \Phi$.

3.2.1 Step 1: Maximize the number of bidders assigned at least two contiguous blocks

Model Formulation for Step 1:

$$\max A_1 = \sum_{i \in N_2} z_i$$

Subject to:

$$\sum_{j \in K_1} x_{i,j} = q_{i,1} \quad \forall i \in N \quad (1)$$

$$\sum_{j \in K_2} x_{i,j} = q_{i,2} \quad \forall i \in N \quad (2)$$

$$\sum_{i \in N \cup \{0\}} x_{i,j} = 1 \quad \forall j \in K \quad (3)$$

$$x_{i,j} \in \{0,1\} \quad \forall i \in N \cup \{0\}, \forall j \in K \quad (4)$$

$$t_{i,j} \leq \frac{1}{2} x_{i,j} + \frac{1}{2} x_{i,j+1} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (5)$$

$$t_{i,j} \in \{0,1\} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (6)$$

$$z_i \leq \sum_{j \in \Phi} t_{i,j} \quad \forall i \in N_2 \quad (7)$$

$$z_i \in \{0,1\} \quad \forall i \in N_2 \quad (8)$$

The objective in this optimization problem is to maximize the number of bidders that are assigned at least two contiguous blocks.

Explanation of Constraints:

- Constraint (1) ensures that each bidder is assigned the number of Category 1 blocks that it won during the clock phase.
- Constraint (2) ensures that each bidder is assigned the number of Category 2 blocks that it won during the clock phase.
- Constraint (3) ensures that each block is assigned to at most one bidder. Moreover, $x_{0,j} = 1$ if and only if block j is assigned to the FCC, *i.e.*, it is not assigned to any bidder.
- Constraint (4) states that each decision variable $x_{i,j}$ can be either equal to 0 or 1.
- Constraints (5) through (8) along with the objective function imply that at an optimal solution $z_i = 1$ if bidder i is assigned at least two contiguous blocks and $z_i = 0$ if bidder i is not assigned any contiguous blocks. In particular:
 - If bidder i is not assigned any contiguous blocks then constraints (5) and (6) imply that $t_{i,j} = 0 \forall j \in \Phi$. Then, $z_i = 0$, because of constraints (7) and (8).
 - If bidder i is assigned at least two contiguous blocks, then $\frac{1}{2} x_{i,j} + \frac{1}{2} x_{i,j+1} = 1$ for at least one $j \in \Phi$, and therefore (5)-(8) imply that $z_i \in \{0,1\}$. Since the objective is to maximize the sum of z_i across all bidders in N_2 , in this case at the optimal solution $z_i = 1$.

After solving the optimization problem described above as Step 1, the algorithm proceeds to Step 2. In Step 2, the goal is to minimize the number of stranded blocks among all allocations that optimize the first objective.

3.2.2 Step 2: Minimize the number of stranded blocks

Additional Variable Definitions for Step 2:

$y_{i,j}$ is a binary decision variable which at the optimal solution has a value of 1 if block j is stranded for bidder i and 0 otherwise. In particular, $y_{i,j} = 1$ if and only if bidder $i \in N_2$ is assigned block j and bidder i is not assigned any block that is contiguous to block j . This variable is defined for all bidders $i \in N_2$ and all blocks $j \in K$.

Model Formulation for Step 2:

$$\min A_2 = \sum_{i \in N_2} \sum_{j \in K} y_{i,j}$$

Subject to:

$$\sum_{j \in K_1} x_{i,j} = q_{i,1} \quad \forall i \in N \quad (1)$$

$$\sum_{j \in K_2} x_{i,j} = q_{i,2} \quad \forall i \in N \quad (2)$$

$$\sum_{i \in N \cup \{0\}} x_{i,j} = 1 \quad \forall j \in K \quad (3)$$

$$x_{i,j} \in \{0,1\} \quad \forall i \in N \cup \{0\}, \forall j \in K \quad (4)$$

$$t_{i,j} \leq \frac{1}{2} x_{i,j} + \frac{1}{2} x_{i,j+1} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (5)$$

$$t_{i,j} \in \{0,1\} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (6)$$

$$z_i \leq \sum_{j \in \Phi} t_{i,j} \quad \forall i \in N_2 \quad (7)$$

$$z_i \in \{0,1\} \quad \forall i \in N_2 \quad (8)$$

$$\sum_{i \in N_2} z_i \geq A_1 \quad (9)$$

$$y_{i,j} \geq x_{i,j} - \sum_{k:(j,k) \in C} x_{i,k} \quad \forall i \in N_2, \forall j \in K \quad (10)$$

$$y_{i,j} \in \{0,1\} \quad \forall i \in N_2, \forall j \in K \quad (11)$$

The objective in this optimization problem is to minimize the number of stranded blocks. Constraints (1) through (8) are the same as in Step 1.

Explanation of New Constraints:

- Constraint (9) states that the number of bidders that are assigned at least two contiguous blocks must be greater than or equal to the result of the first optimization.
- Constraints (10) and (11) along with the objective function imply that at an optimal solution $y_{i,j} = 1$ if block j is a stranded block for bidder i , and $y_{i,j} = 0$ if block j is not a stranded block for bidder i . In particular:
 - If block j is a stranded block for bidder i , then $x_{i,j} = 1$ (that is, bidder i is assigned block j) and $\sum_{k:(j,k) \in C} x_{i,k} = 0$ (that is, bidder i is not assigned any block that is contiguous to block j). These imply that $x_{i,j} - \sum_{k:(j,k) \in C} x_{i,k} = 1$. Therefore, $y_{i,j} = 1$, because of (8) and (9).
 - If block j is not a stranded block for bidder i , then either (i) $x_{i,j} = 0$ (that is, bidder i is not assigned block j) or (ii) $x_{i,j} = 1$ and $\sum_{k:(j,k) \in C} x_{i,k} \geq 1$ (that is, bidder i is assigned block j and at least one block that is contiguous to block j). In either case, $x_{i,j} - \sum_{k:(j,k) \in C} x_{i,k} \leq 0$. Then, (8) and (9) imply that $y_{i,j} \in \{0,1\}$. Since the objective is to

minimize the sum of $y_{i,j}$ across all bidders in N_2 and all blocks in K , in this case at the optimal solution $y_{i,j} = 0$.

After solving the optimization problem described above as Step 2, the algorithm proceeds to Step 3. In Step 3, the goal is to maximize the number of bidders whose blocks are all contiguous with one another among all allocations that optimize Step 2.

3.2.3 Step 3: Maximize the number of bidders with all contiguous blocks

Additional Variable Definitions for Step 3:

w_i is a binary decision variable which at the optimal solution has a value of 1 if all the blocks assigned to bidder i are contiguous and 0 otherwise. This variable is defined for all bidders $i \in N_2$.

Model Formulation for Step 3:

$$\max A_3 = \sum_{i \in N_2} w_i$$

Subject to:

$$\sum_{j \in K_1} x_{i,j} = q_{i,1} \quad \forall i \in N \quad (1)$$

$$\sum_{j \in K_2} x_{i,j} = q_{i,2} \quad \forall i \in N \quad (2)$$

$$\sum_{i \in N \cup \{0\}} x_{i,j} = 1 \quad \forall j \in K \quad (3)$$

$$x_{i,j} \in \{0,1\} \quad \forall i \in N \cup \{0\}, \forall j \in K \quad (4)$$

$$t_{i,j} \leq \frac{1}{2} x_{i,j} + \frac{1}{2} x_{i,j+1} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (5)$$

$$t_{i,j} \in \{0,1\} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (6)$$

$$z_i \leq \sum_{j \in \Phi} t_{i,j} \quad \forall i \in N_2 \quad (7)$$

$$z_i \in \{0,1\} \quad \forall i \in N_2 \quad (8)$$

$$\sum_{i \in N_2} z_i \geq A_1 \quad (9)$$

$$y_{i,j} \geq x_{i,j} - \sum_{k:(j,k) \in C} x_{i,k} \quad \forall i \in N_2, \forall j \in K \quad (10)$$

$$y_{i,j} \in \{0,1\} \quad \forall i \in N_2, \forall j \in K \quad (11)$$

$$\sum_{i \in N_2} \sum_{j \in K} y_{i,j} \leq A_2 \quad (12)$$

$$w_i \leq \frac{1}{q_i-1} \sum_{j \in \Phi} t_{i,j} \quad \forall i \in N_2 \quad (13)$$

$$w_i \in \{0,1\} \quad \forall i \in N_2 \quad (14)$$

The objective in this optimization problem is to maximize the number of bidders whose blocks are all contiguous with one another. Constraints (1)–(11) are the same as in Step 2.

Explanation of New Constraints:

- Constraint (12) states that the number of stranded blocks must be less than or equal to the result of the second optimization.
- Constraints (13) and (14) along with the objective function and constraints (5) and (6) imply that at an optimal solution $w_i = 1$ if all blocks assigned to bidder i are contiguous and $w_i = 0$ otherwise. In particular:

- If not all blocks assigned to bidder i are contiguous with one another, then by constraints (5) and (6) $t_{i,j} = 0$ for all but at most $q_i - 2$ blocks. Then, (13) and (14) imply that $w_i = 0$.
- If all blocks assigned to bidder i are contiguous with one another, then there exists some block α such that:
 - $x_{i,j} = 1$ for $j = \alpha, \alpha + 1, \dots, \alpha + q_i - 1$
 - $j \in \Phi$ for $j = \alpha, \alpha + 1, \dots, \alpha + q_i - 2$

Equation (5) then implies that $t_{i,j} \leq 1$ for $j = \alpha, \alpha + 1, \dots, \alpha + q_i - 2$, and thus $\sum_{j \in \Phi} t_{i,j} \leq q_i - 1$. Then, (13) and (14) imply that $w_i \in \{0,1\}$. Since the objective is to maximize the sum of w_i across all bidders in N_2 , in this case at the optimal solution $w_i = 1$.

3.2.4 Step 4: Maximize impairments and contiguity across unsold blocks

Overview of Step 4:

Step 4 consists of solving two optimization problems. With the first optimization problem the auction system maximizes the sum of impairments across unsold blocks over all assignments that optimize Steps 1 through 3; denote the maximum by L . It then maximizes the number of contiguous unsold blocks subject to the constraint that the corresponding sum of impairments is at least L .

First Model Formulation for Step 4: Maximize sum of impairments across unsold blocks

$$\max L = \sum_{j \in K} d_j \cdot x_{0,j}$$

Subject to:

$$\sum_{j \in K_1} x_{i,j} = q_{i,1} \quad \forall i \in N \quad (1)$$

$$\sum_{j \in K_2} x_{i,j} = q_{i,2} \quad \forall i \in N \quad (2)$$

$$\sum_{i \in N \cup \{0\}} x_{i,j} = 1 \quad \forall j \in K \quad (3)$$

$$x_{i,j} \in \{0,1\} \quad \forall i \in N \cup \{0\}, \forall j \in K \quad (4)$$

$$t_{i,j} \leq \frac{1}{2} x_{i,j} + \frac{1}{2} x_{i,j+1} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (5)$$

$$t_{i,j} \in \{0,1\} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (6)$$

$$z_i \leq \sum_{j \in \Phi} t_{i,j} \quad \forall i \in N_2 \quad (7)$$

$$z_i \in \{0,1\} \quad \forall i \in N_2 \quad (8)$$

$$\sum_{i \in N_2} z_i \geq A_1 \quad (9)$$

$$y_{i,j} \geq x_{i,j} - \sum_{k: (j,k) \in C} x_{i,k} \quad \forall i \in N_2, \forall j \in K \quad (10)$$

$$y_{i,j} \in \{0,1\} \quad \forall i \in N_2, \forall j \in K \quad (11)$$

$$\sum_{i \in N_2} \sum_{j \in K} y_{i,j} \leq A_2 \quad (12)$$

$$w_i \leq \frac{1}{q_i - 1} \sum_{j \in \Phi} t_{i,j} \quad \forall i \in N_2 \quad (13)$$

$$w_i \in \{0,1\} \quad \forall i \in N_2 \quad (14)$$

$$\sum_{i \in N_2} w_i \geq A_3 \quad (15)$$

The objective in this optimization problem is to maximize the sum of impairments across unsold blocks. Constraints (1) through (14) are the same as in Step 3.

Explanation of New Constraints:

- Constraint (15) states that the number of bidders that get contiguous spectrum must be greater than or equal to the result of the third optimization.

Second Model Formulation for Step 4: Maximize number of pairs of contiguous unsold blocks

$$\max A_4 = \sum_{j \in \Phi} t_{0,j}$$

Subject to:

$$\sum_{j \in K_1} x_{i,j} = q_{i,1} \quad \forall i \in N \quad (1)$$

$$\sum_{j \in K_2} x_{i,j} = q_{i,2} \quad \forall i \in N \quad (2)$$

$$\sum_{i \in N \cup \{0\}} x_{i,j} = 1 \quad \forall j \in K \quad (3)$$

$$x_{i,j} \in \{0,1\} \quad \forall i \in N \cup \{0\}, \forall j \in K \quad (4)$$

$$t_{i,j} \leq \frac{1}{2} x_{i,j} + \frac{1}{2} x_{i,j+1} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (5)$$

$$t_{i,j} \in \{0,1\} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (6)$$

$$z_i \leq \sum_{j \in \Phi} t_{i,j} \quad \forall i \in N_2 \quad (7)$$

$$z_i \in \{0,1\} \quad \forall i \in N_2 \quad (8)$$

$$\sum_{i \in N_2} z_i \geq A_1 \quad (9)$$

$$y_{i,j} \geq x_{i,j} - \sum_{k:(j,k) \in C} x_{i,k} \quad \forall i \in N_2, \forall j \in K \quad (10)$$

$$y_{i,j} \in \{0,1\} \quad \forall i \in N_2, \forall j \in K \quad (11)$$

$$\sum_{i \in N_2} \sum_{j \in K} y_{i,j} \leq A_2 \quad (12)$$

$$w_i \leq \frac{1}{q_i - 1} \sum_{j \in \Phi} t_{i,j} \quad \forall i \in N_2 \quad (13)$$

$$w_i \in \{0,1\} \quad \forall i \in N_2 \quad (14)$$

$$\sum_{i \in N_2} w_i \geq A_3 \quad (15)$$

$$\sum_{j \in K} d_j \cdot x_{0,j} \geq L \quad (M)$$

The objective in this optimization problem is to maximize the number of pairs of unsold blocks that are contiguous. This objective together with constraints (5) and (6) imply that for every block $j \in \Phi$, at an optimal solution $t_{0,j} = 1$ if both blocks j and $j + 1$ are unsold and $t_{0,j} = 0$ otherwise. In particular:

- If at least one of the blocks j and $j + 1$ is assigned to some bidder, then $t_{0,j} = 0$.
- If both blocks j and $j + 1$ are not assigned to any bidder and $j \in \Phi$, then $t_{0,j} \in \{0,1\}$. Since the objective is to maximize the sum of $t_{0,j}$ across all blocks in Φ , in this case at the optimal solution $t_{0,j} = 1$.

Constraints (1) through (15) are the same as in the first optimization for Step 4.

Explanation of New Constraints:

- Constraint (M) states that the sum of impairments across unsold blocks must be greater than or equal to L , *i.e.*, the result of the first optimization of Step 4.

4 Information Policy**4.1 State**

For each assignment phase market, the auction system solves the optimizations in Steps 1–4 of Section 3.2 and determines which one of the following *states* applies:

- It is feasible to assign all contiguous spectrum to every bidder;
- It is feasible to assign at least two contiguous blocks to every bidder (that won at least two blocks in the clock phase), but it is not feasible to assign all contiguous spectrum to every bidder; or

It is not feasible to assign at least two contiguous blocks to every bidder that won at least two blocks in the clock phase.

The state of each assignment phase market will be disclosed to all bidders participating in the assignment phase (not just the bidders that have clock phase winnings in that market) before bidding in the assignment phase starts.

Below are examples of the various contiguity outcome states.

Example 1: Feasible to Assign All Contiguous Spectrum

Consider the 108 megahertz band plan shown below where all eight blocks are in Category 1.

A	B	3	37	3	C	D	E	F	G	H
---	---	---	----	---	---	---	---	---	---	---

There are three bidders with the following clock phase winnings:

- Bidder 1: three Category 1 blocks
- Bidder 2: three Category 1 blocks
- Bidder 3: two Category 1 blocks

The state is the following:

“It is feasible to assign all contiguous spectrum to every bidder.”

This state occurs because Bidder 3 can be assigned AB and Bidder 1 and Bidder 2 can be assigned to either CDE or FGH which are all contiguous.

Example 2: Feasible to Assign at Least Two Contiguous Blocks

Consider the 84 megahertz band plan so that all blocks (A through G) are located above Channel 37. Suppose that in a PEA, blocks B and C are Category 2, while the rest are Category 1 blocks.

37	3	A	B	C	D	E	F	G
----	---	---	---	---	---	---	---	---

If there are three winners from the clock phase, where one bidder has won three Category 1 blocks, one bidder has won two Category 1 blocks, and one bidder has won two Category 2 blocks, the state is the following:

“It is feasible to assign at least two contiguous blocks to every bidder (who won at least two blocks in the clock phase), but it is not feasible to assign all contiguous spectrum to every bidder.”

This state occurs because it is not possible to assign the bidder that won three Category 1 blocks all contiguous blocks and at the same time assign the bidder that won two Category 1 blocks all contiguous blocks. However, it is possible to assign at least two contiguous blocks to both bidders.

Example 3: Not Feasible to Assign at Least Two Contiguous Blocks

Consider the 84 megahertz band plan so that all blocks (A through G) are located above Channel 37. Suppose that in a PEA, blocks A and G are Category 2, while the rest are Category 1 blocks.

37	3	A	B	C	D	E	F	G
----	---	---	---	---	---	---	---	---

If there are three winners from the clock phase, where one bidder has won three Category 1 blocks, one bidder has won two Category 1 blocks, and one bidder has won two Category 2 blocks, the state is the following:

“It is not feasible to assign at least two contiguous blocks to every bidder who won at least two blocks in the clock phase.”

Specifically, in this case it is not feasible to assign contiguous blocks to the bidder that won two Category 2 blocks.

4.2 Winning Assignments and Payments

After bidding in an assignment round concludes, the bids are processed to determine the winning assignments and the payments for that round. For each assignment phase market of the round, each bidder is then informed about its winning assignment, its assignment phase payment for that assignment phase market (see Section 7.2), and other payment information depending on whether it qualifies for a bidding credit (see Section 8 for details). This information is disclosed to the bidder before the next assignment round starts.

5 Bidding

5.1 Bidding Options

For each assignment phase market and each bidder, the auction system will determine all assignment options that are consistent with the “positive information” of the disclosed state (see Section 4.1) and that bidder’s clock phase winnings. This set is referred to as the *bidding options* of the bidder.

Specifically, if the disclosed state is:

“It is feasible to assign all contiguous spectrum to every bidder,”

a bidder’s bidding options consist of all assignments that are consistent with the bidder’s clock phase winnings where the spectrum is contiguous.⁶

If the disclosed state is:

“It is feasible to assign at least two contiguous blocks to every bidder (that won at least two blocks in the clock phase), but it is not feasible to assign all contiguous spectrum to every bidder”,

then the “positive information” in the disclosed state is that “it is feasible to assign at least two contiguous blocks to every bidder (that won at least two blocks in the clock phase)”. Thus, the bidding options of a bidder that won at least two blocks in the clock phase consist of all assignments that are consistent with the bidder’s clock phase winnings where the bidder gets two or more contiguous blocks.

⁶ In this case, the disclosed state contains only “positive information,” it does not contain any negative information.

Finally, if the disclosed state is:

“It is not feasible to assign at least two contiguous blocks to every bidder who won at least two blocks in the clock phase”,

then the disclosed state does not contain any “positive information.” Thus, a bidder’s bidding options will consist of all assignments that are consistent with its clock phase winnings.

The examples of Section 4.1 are shown below with the bidding options of every bidder provided in each example.

Example 1: Feasible to Assign All Contiguous Spectrum

The 108 megahertz plan with all eight blocks in Category 1.

A	B	3	37	3	C	D	E	F	G	H
---	---	---	----	---	---	---	---	---	---	---

There are three bidders with clock phase winnings:

- Bidder 1: three Category 1 blocks
- Bidder 2: three Category 1 blocks
- Bidder 3: two Category 1 blocks

The state is the following:

“It is feasible to assign all contiguous spectrum to every bidder.”

The bidding options of Bidder 1 are: CDE, DEF, EFG, and FGH. These are all the assignments that are consistent with the state and the clock phase winnings of Bidder 1. The bidder can bid on any of these bidding options. However, note that some of the bidding options cannot occur. For instance, Bidder 1 cannot be assigned DEF, because, if it were, it would not be possible to assign contiguous spectrum to Bidder 2. The bid options of a bidder are not limited only to the options that can be won by the bidder, since limiting bid options to those fully consistent with the disclosed state may permit a bidder to infer the winnings of other bidders.

The bidding options of Bidder 2 are the same as for Bidder 1: CDE, DEF, EFG, and FGH.

The bidding options of Bidder 3 are: AB, CD, DE, EF, FG, and GH.

Example 2: Feasible to Assign at Least Two Contiguous Blocks

The 84 megahertz plan with all blocks (A through G) located above Channel 37. In some PEA, blocks B and C are Category 2, while the rest are Category 1 blocks.

37	3	A	B	C	D	E	F	G
----	---	---	---	---	---	---	---	---

If there are three winners from the clock phase, where bidder 1 has won three Category 1 blocks, bidder 2 has won two Category 1 blocks, and bidder 3 has won two Category 2 blocks, the state is the following:

“It is feasible to assign at least two contiguous blocks to every bidder (who won at least two blocks in the clock phase), but it is not feasible to assign all contiguous spectrum to every bidder.”

The bidding options for each bidder are shown in the table below.

Bidder	Clock Phase Winnings	Bidding Options
1	Three Category 1 blocks	ADE, AEF, AFG, DEF, EFG, DEG, DFG
2	Two Category 1 blocks	DE, EF, FG
3	Two Category 2 blocks	BC

Example 3: Not Feasible to Assign at Least Two Contiguous Blocks

The 84 megahertz plan with all blocks (A through G) located above Channel 37. In some PEA, blocks A and G are Category 2, while the rest are Category 1 blocks.



If there are three winners from the clock phase, where bidder 1 has won three Category 1 blocks, bidder 2 has won two Category 1 blocks, and bidder 3 has won two Category 2 blocks, the state is the following:

“It is not feasible to assign at least two contiguous blocks to every bidder who won at least two blocks in the clock phase.”

Specifically, in this case it is not feasible to assign contiguous blocks to the bidder that won two Category 2 blocks. Therefore, the bidding options for each bidder are:

Bidder	Clock Phase Winnings	Bidding Options
1	Three Category 1 blocks	BCD, BCE, BCF, BDE, BDF, BEF, CDE, CDF, CEF, DEF
2	Two Category 1 blocks	BC, BD, BE, BF, CD, CE, CF, DE, DF, EF
3	Two Category 2 blocks	AG

5.2 Bidding Rules

A bidder may specify a bid value for each bidding option that it is presented with for an assignment phase market. The bidder bids for a bidding option by specifying a non-negative whole dollar amount for that option.

A bidder that does not have clock phase winnings in a PEA will not have any bidding options in the corresponding assignment phase market and thus cannot submit bids for that market.

If a bidder has only one bidding option available in an assignment phase market, the bidder will be automatically assigned the licenses in this option and will not be able to place bids for this assignment phase market. If all winners in a PEA have only one bidding option available to each of them, then all licenses in that PEA are pre-assigned to winners and there will not be a round held for that PEA.⁷ Similarly, if a PEA has no winners from the clock phase (all blocks remained unsold), there will not be a round held for that PEA.

If the assignment phase market of a round is a group of PEAs, then each bidder has the same clock phase winnings in all of those PEAs (because of the grouping rule described in Section 2.1). By specifying a bid value for a bidding option, the bidder indicates the maximum amount that it is willing to pay to be assigned that option in all those PEAs. A bidder will not be able to bid for different frequency assignments in the various PEAs in a group.

A winner of the clock phase is not required to bid in the assignment phase. In particular, such a bidder may not wish to bid if it is indifferent among all assignments that it may get. The auction system will consider a bid value of zero for any set of blocks for which a bidder submits no bid.

⁷ If a bidder does not have the option of bidding in an assignment round, the assignment phase payment associated with its assignment will be equal to 0.

6 Assignment Determination

The winning assignment is determined by maximizing the sum of bid values subject to all of the assignment phase objectives being maximized lexicographically. Ties, if any, are broken by including pseudo-random numbers in an optimization.

To mathematically formulate the assignment determination, the following notation is used in addition to the notation of Section 3.2:

- S denotes a set of blocks. For each block j , S_j denotes the indicator variable of whether block j is in set S . That is, $S_j = 1$ if $j \in S$, and $S_j = 0$ if $j \notin S$.
- $b_i(S)$ denotes the bid value of bidder i for set S .
- b denotes the set of bid values.
- F_i denotes the set of bidding options for bidder i (see Section 5). That is, F_i will consist of all sets $S \subseteq K$ that are consistent with the clock phase winnings of bidder i and the disclosed state.

The assignment determination is done by solving two optimization problems. The first optimization problem finds the maximum sum of bid values among all assignments that maximize the assignment phase objectives lexicographically. The maximum is denoted by $r(N, b)$. The auction system then solves another optimization problem using randomly generated numbers to break ties, if any. The solution to the latter optimization is selected as the final assignment.

Additional Variable Definitions:

$X_i(S)$ is a binary decision variable which has a value of 1 if exactly the blocks of set S are assigned to bidder i and 0 otherwise. This variable is defined for all bidders $i \in N$.

6.1 Maximum Sum of Bid Values

$$\max r(N, b) = \sum_{i \in N} \sum_{S \in F_i} b_i(S) \cdot X_i(S)$$

Subject to:

$$\sum_{j \in K_1} x_{i,j} = q_{i,1} \quad \forall i \in N \quad (1)$$

$$\sum_{j \in K_2} x_{i,j} = q_{i,2} \quad \forall i \in N \quad (2)$$

$$\sum_{i \in N \cup \{0\}} x_{i,j} = 1 \quad \forall j \in K \quad (3)$$

$$x_{i,j} \in \{0,1\} \quad \forall i \in N \cup \{0\}, \forall j \in K \quad (4)$$

$$t_{i,j} \leq \frac{1}{2} x_{i,j} + \frac{1}{2} x_{i,j+1} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (5)$$

$$t_{i,j} \in \{0,1\} \quad \forall i \in N_2 \cup \{0\}, \forall j \in \Phi \quad (6)$$

$$z_i \leq \sum_{j \in \Phi} t_{i,j} \quad \forall i \in N_2 \quad (7)$$

$$z_i \in \{0,1\} \quad \forall i \in N_2 \quad (8)$$

$$\sum_{i \in N_2} z_i \geq A_1 \quad (9)$$

$$y_{i,j} \geq x_{i,j} - \sum_{k:(j,k) \in C} x_{i,k} \quad \forall i \in N_2, \forall j \in K \quad (10)$$

$$y_{i,j} \in \{0,1\} \quad \forall i \in N_2, \forall j \in K \quad (11)$$

$$\sum_{i \in N_2} \sum_{j \in K} y_{i,j} \leq A_2 \quad (12)$$

$$w_i \leq \frac{1}{q_i-1} \sum_{j \in \Phi} t_{i,j} \quad \forall i \in N_2 \quad (13)$$

$$w_i \in \{0,1\} \quad \forall i \in N_2 \quad (14)$$

$$\sum_{i \in N_2} w_i \geq A_3 \quad (15)$$

$$\sum_{j \in \Phi} t_{0,j} \geq A_4 \quad (16)$$

$$x_{i,j} = \sum_{S \in F_i} S_j \cdot X_i(S) \quad \forall i \in N, \forall j \in K \quad (17)$$

$$\sum_{S \in F_i} X_i(S) = 1 \quad \forall i \in N \quad (18)$$

$$X_i(S) \in \{0,1\} \quad \forall i \in N, \forall S \in F_i \quad (19)$$

The objective function is equal to the sum of bid values of an assignment, across all bidders. Constraints (1) through (15) are the same as in the second optimization of Step 4 in Section 3.2.4.⁸

Explanation of New Constraints:

- Constraint (16) states that the number of pairs of contiguous unsold blocks must be greater than or equal to the result of the second optimization of Step 4 in Section 3.2.4.⁹
- Constraints (17)–(19) ensure that the set S is assigned to bidder i (that is, $X_i(S) = 1$) if and only if $x_{i,j} = 1$ for all blocks j in set S and $x_{i,j} = 0$ for all blocks j not in S (that is, with $S_j = 0$).
- Constraint (18) ensures that each bidder is assigned exactly one set of blocks.
- Constraint (19) states that each decision variable $X_i(S)$ can be either equal to 0 or 1.

6.2 Tie-breaking

For every set S and every bidder $i \in N$, the auction system generates a pseudo-random number $\xi_i(S)$ drawn uniformly at random from the set $\{1, 2, \dots, 10^8\}$. The auction system then solves an optimization problem to find the assignment that maximizes the sum of pseudorandom numbers among all assignments that satisfy constraints (1) through (19) of Section 6.1 such that the sum of bid values is equal to $r(N, b)$. In particular, the optimization problem is formulated as follows:

$$\max \sum_{i \in N} \sum_{S \in F_i} \xi_i(S) \cdot X_i(S)$$

Subject to:

$$\sum_{j \in K_1} x_{i,j} = q_{i,1} \quad \forall i \in N \quad (1)$$

$$\sum_{j \in K_2} x_{i,j} = q_{i,2} \quad \forall i \in N \quad (2)$$

$$\sum_{i \in N \cup \{0\}} x_{i,j} = 1 \quad \forall j \in K \quad (3)$$

⁸ At the optimal solution, (i) $z_i = 1$ if and only if bidder i is assigned at least two contiguous blocks, (ii) $y_{i,j} = 1$ if and only if block j is stranded for bidder i , and (iii) $w_i = 1$ if and only if bidder i is assigned blocks that are all contiguous to one another. If either of these conditions were violated, that would imply that A_1 , A_2 , and A_3 do not represent the optimal values of the assignment phase objectives when optimizing lexicographically.

⁹ Note that the constraint (M) of Section 3.2 is not imposed here. However, the system will require that the number of pairs of contiguous unsold blocks is greater than or equal to A_4 . For instance, in Case 1 of Example 3 in Section 3.1, the optimization will require that the two unsold blocks are contiguous but will not require that the unsold blocks are A and B. The optimization will not prevent a bidder from being assigned blocks AB. A bidder can win blocks AB by setting a sufficiently high bid value for those blocks.

$x_{i,j} \in \{0,1\}$	$\forall i \in N \cup \{0\}, \forall j \in K$	(4)
$t_{i,j} \leq \frac{1}{2} x_{i,j} + \frac{1}{2} x_{i,j+1}$	$\forall i \in N_2 \cup \{0\}, \forall j \in \Phi$	(5)
$t_{i,j} \in \{0,1\}$	$\forall i \in N_2 \cup \{0\}, \forall j \in \Phi$	(6)
$z_i \leq \sum_{j \in \Phi} t_{i,j}$	$\forall i \in N_2$	(7)
$z_i \in \{0,1\}$	$\forall i \in N_2$	(8)
$\sum_{i \in N_2} z_i \geq A_1$		(9)
$y_{i,j} \geq x_{i,j} - \sum_{k:(j,k) \in C} x_{i,k}$	$\forall i \in N_2, \forall j \in K$	(10)
$y_{i,j} \in \{0,1\}$	$\forall i \in N_2, \forall j \in K$	(11)
$\sum_{i \in N_2} \sum_{j \in K} y_{i,j} \leq A_2$		(12)
$w_i \leq \frac{1}{q_i-1} \sum_{j \in \Phi} t_{i,j}$	$\forall i \in N_2$	(13)
$w_i \in \{0,1\}$	$\forall i \in N_2$	(14)
$\sum_{i \in N_2} w_i \geq A_3$		(15)
$\sum_{j \in \Phi} t_{0,j} \geq A_4$		(16)
$x_{i,j} = \sum_{S \in F_i} S_j \cdot X_i(S)$	$\forall i \in N, \forall j \in K$	(17)
$\sum_{S \in F_i} X_i(S) = 1$	$\forall i \in N$	(18)
$X_i(S) \in \{0,1\}$	$\forall i \in N, \forall S \in F_i$	(19)
$\sum_{i \in N} \sum_{S \in F_i} b_i(S) \cdot X_i(S) \geq r(N, b)$		(20)

Constraints (1) through (19) are the same as in the optimization of Section 6.1.

Explanation of New Constraints:

- Constraint (20) states that the sum of bid values must be greater than or equal to the result of the optimization of Section 6.1.

7 Payment Determination

7.1 Discounts for Impairments

When determining a bidder's final payments after the assignment phase, the final clock phase price of a product will be discounted depending on the impairment percentage of the specific block that is assigned. In particular, the final clock phase price for a block that is $x\%$ impaired will be discounted by $x\%$.

The *impairment adjusted price* of a license that is $x\%$ impaired is equal to:

$$\left(1 - \frac{x}{100}\right) \cdot P_r$$

where P_r denotes the final clock phase price of the corresponding product. Impairment discounts will be rounded to the nearest dollar.

Example:

Suppose that

- Block A is 25% impaired
- Block B is 16% impaired

Block C is 8% impaired

Block D is 4% impaired

Blocks A and B are Category 2 blocks (because each is more than 15% impaired). If the final clock phase price for Category 2 blocks is \$20 million, then the impairment-adjusted clock phase price of Block A is $(0.75) \cdot (\$20 \text{ million}) = \15 million and of Block B is $(0.84) \cdot (\$20 \text{ million}) = \16.8 million .

Blocks C and D are Category 1 blocks (because each is 15% or less impaired). If the final clock phase price for Category 1 blocks is \$25 million, then the impairment-adjusted clock phase price of Block C is $(0.92) \cdot (\$25 \text{ million}) = \23 million and of Block D is $(0.96) \cdot (\$25 \text{ million}) = \24 million .

7.2 Assignment Phase Payment (for an assignment phase market)

The assignment phase payment that the bidder will pay for the set of licenses it is assigned in an assignment phase market is the additional payment amount above the sum of impairment-adjusted clock phase prices before bidding credits are applied. If a bidder did not bid (or placed a bid of zero) for the set of licenses that it is assigned, then no additional calculation is necessary, and the bidder will not have any additional assignment phase payment for that assignment phase market. If, on the other hand, the bidder placed a positive bid for the winning assignment, then the auction system will calculate a type of ‘second-price’ assignment phase payment.¹⁰

To determine this price, the auction system will calculate a price for each bidder that would have been “just sufficient” to result in the same winning assignment set. For each bidder, the auction system will re-solve the optimization problem of Section 6.1, but setting all bids of the bidder to zero while keeping the bids of every other bidder unchanged from the prior optimization, and calculate a hypothetical maximum revenue from that optimization. The difference between the revenue associated with the actual optimization and the hypothetical maximum revenue that would occur had that bidder provided all bids of zero will indicate the amount by which the bidder’s winning bid amount exceeded the minimum amount it would have needed to bid to ensure the same winning assignment set. Its assignment phase payment will subtract that amount from its actual bid amount.

Specifically: Recall that $r(N, b)$ denotes the maximum value attained by solving the optimization problem of Section 6.1, when the set of winners is N and the set of bid values is b . Let S_j^* denote the set of blocks that bidder j is assigned in the optimal solution.

The assignment phase payment of bidder j in a given assignment phase market is set to be equal to:

$$b_j(S_j^*) - (r(N, b) - r(N, b_{j \rightarrow 0}))$$

where $b_{j \rightarrow 0}$ represents the set of bid values where the bid values of all bids of bidder j are set to zero (and the bid values of every other bidder are not changed).

7.3 Adjusted Gross Payment (for an assignment phase market)

The *Adjusted Gross Payment* of a bidder in an assignment phase market is the sum of the impairment adjusted clock phase prices for all licenses in the bidder’s assignment *and* the bidder’s assignment phase payment in that assignment phase market.¹¹ Note that an assignment phase market may consist of one or more PEAs.

¹⁰ In some cases, this may also be zero.

¹¹ In the event that a winning bidder is ineligible for a bidding credit in a particular market pursuant to the Commission’s rules, the final forward auction payment may later be adjusted to reflect differences in the markets to which the bidding credit cap applies. *Updating Competitive Bidding Rules*, 80 Fed. Reg. 56,763, 56,771–73 (Sept. 18, 2015) (to be codified at 47 C.F.R. 1.2110); see generally *Part 1 R&O*, 30 FCC Rcd at 7512–16, paras. 42–53.

If a bidder's clock phase winnings include both reserved and unreserved blocks for a PEA, the approach to determine the reserved license in the assignment phase is as follows:

If the unreserved price from the clock phase is greater than or equal to the reserved price for the Category 1 blocks in that PEA, the Category 1 license(s) with the lowest impairment are designated as the reserved license(s) in the assignment phase.

If the unreserved price from the clock phase is less than the reserved price for the Category 1 blocks in that PEA, the Category 1 license(s) with the highest impairment are designated as the reserved license(s) in the assignment phase.

If the above calculations lead to a tie with more than one license and the auction system needs to choose which of these tied licenses is/are designated as reserved, the auction system will designate the license(s) with the highest frequency as reserved.

Example: Designating Reserved/Unreserved Licenses

A bidder has won three reserved Category 1 blocks and one unreserved Category 1 block in a given PEA in the clock phase. The final clock phase price for the reserved product is \$1,000. The final clock phase price for the unreserved product is \$1,200. That is, the unreserved price is greater than the reserved price. That PEA was not grouped with any other PEA in the assignment phase. In that PEA, the bidder was assigned licenses corresponding to blocks EFGH with assignment phase payment equal to \$100. Suppose that the license corresponding to block E is 2 percent impaired and licenses corresponding to blocks F, G and H are 0 percent impaired. Then, the adjusted gross payment of the bidder for this assignment phase market is:

$$(1,200 * 0.98 + 1,000 + 1,000 + 1,000) + (100) = \$4,276$$

The license corresponding to block E (the most impaired license) is designated as unreserved in the calculation. On the other hand, the licenses corresponding to blocks F, G, and H (the least impaired blocks) are designated as reserved.

7.4 Final Forward Auction Payment

When all assignment rounds have completed, a bidder's final forward auction payment is determined by summing its adjusted gross payments across all assignment phase markets and then applying any applicable bidding credit discounts to the sum.

This section uses the following notation:

- BC denotes the bidder's bidding credit percentage (e.g., 25 percent)
- AGP_k denotes the bidder's adjusted gross payment in assignment phase market k
- SM denotes the set of assignment phase markets that consist solely of PEAs subject to the small market bidding cap.¹²
- M denotes the set of assignment phase markets

For a bidder that does not qualify for any bidding credits, the final forward auction payment is:

$$\sum_{k \in M} AGP_k$$

This is simply the sum of the bidder's adjusted gross payments across all assignment phase markets.

¹² Note that according to the rules for grouping PEAs into a single assignment phase market described in Section 2.1, *either* all PEAs in an assignment phase market are subject to the small market bidding credit cap *or* none of the PEAs in that assignment phase market are subject to the small markets bidding credit cap.

For a bidder that qualifies for the rural bidding credit, the final forward auction payment is:

$$\sum_{k \in M} AGP_k - \min \left\{ \$10 \text{ million}, BC \cdot \sum_{k \in M} AGP_k \right\}$$

That is, to compute the applicable discount, the sum of the bidder's adjusted gross payments across all assignment phase markets is multiplied by its bidding credit and capped at 10 million.

For a bidder that qualifies for the small business bidding credit, the final forward auction payment is:

$$\sum_{k \in M} AGP_k - \min \left\{ \$150 \text{ million}, BC \cdot \sum_{k \in M \setminus SM} AGP_k + \min \left\{ \$10 \text{ million}, BC \cdot \sum_{k \in SM} AGP_k \right\} \right\}$$

The calculation first caps the discount from small markets at \$10 million, then adds the discount from all other markets and caps the total at \$150 million.

8 Calculations for Payment Information During Assignment Phase

While winning bidders will be expected to pay the final forward auction payment set forth immediately above, during the assignment phase, the auction system will show a bidder various calculations intended to give the bidder a running estimate of its auction payment obligations. After each assignment round, each bidder will be shown its current adjusted payment (across PEAs for which an assignment round has already completed) and its current unadjusted commitment (across PEAs that have not been assigned yet). A bidder that qualifies for a bidding credit will be shown gross and net amounts for its adjusted payment and unadjusted commitment as well as its corresponding capped and uncapped discounts. This way a bidder will know if it has reached any applicable bidding credit caps and the amount by which it is under or over. Moreover, this information will provide the bidder a running estimate during the assignment rounds of the dollar amount it will owe at the end of the auction.

The table below illustrates the values that will be shown and updated after each assignment round. If a bidder does not have a bidding credit discount then only the gross amounts are shown. An additional column will be shown to bidders that qualify for the small business bidding credit, as described in Section 8.4.2.

	Gross	Discount Capped	Net	Discount Uncapped
Adjusted Payment	Total adjusted payments	Total discount for adjusted payments with any applicable caps applied	Gross adjusted payment minus capped discount	Total discount for adjusted payments without any applicable caps applied
Unadjusted Commitment	Total unadjusted commitments	Remaining discount within applicable caps, if any	Gross unadjusted commitment minus remaining discount	Total discount for unadjusted commitment without any applicable caps applied
Total	Total gross amount	Total discounts capped	Total net amount	Total discounts uncapped

The following notation is used to give formulas for how adjusted payments, unadjusted commitment and the corresponding capped and uncapped bidding credit discounts are calculated for a given bidder:

- BC denotes the bidder's bidding credit percentage (e.g., 25 percent)
- AGP_k denotes the bidder's adjusted gross payment in assignment phase market k
- C denotes the set of assignment phase markets for which an assignment has been processed. Note that C increases after every round.

- N denotes the set of *products* that are not in a market in C , *i.e.*, an assignment has not been processed for these products. Note that N decreases after every round.
- SM denotes the set of assignment phase markets that consist solely of PEAs subject to the small market bidding cap
- SP denotes the set of *products* that are in a market subject to the small market bidding cap
- d_r denotes the bidder's clock phase winnings for product r
- P_r denotes the final clock phase price for product r

All the discount calculations described in Sections 8.2 and 8.4 will be rounded to the nearest dollar.

8.1 Gross amounts

The bidder's *gross adjusted payment* is given by the following formula:

$$\sum_{k \in C} AGP_k$$

This is the sum of the bidder's adjusted gross payments across all markets for which an assignment has been processed.

The bidder's *gross unadjusted commitment* is given by the following formula:

$$\sum_{r \in N} d_r \cdot P_r$$

Observe that $d_r \cdot P_r$ is an estimate of what the bidder owes for its clock phase winnings of product r at the end of the clock phase. The sum is over all products for which an assignment has not been processed. Therefore, the bidder's gross unadjusted commitment provides an upper bound for what the bidder will owe for all products for which an assignment has not been processed if it submits no bids in the remaining assignment rounds. Any impairment discounts for specific license assignments will reduce the actual amount. On the other hand, any assignment phase payments will increase the actual amount.

8.2 Capped discounts

8.2.1 For Adjusted Payment

The *capped adjusted payment discount* for a bidder that qualifies for the rural bidding credit is:

$$\min \left\{ \$10 \text{ million}, BC \cdot \sum_{k \in C} AGP_k \right\}$$

That is, the bidder's gross adjusted payment is multiplied by its bidding credit percentage and capped at 10 million.

The *capped adjusted payment discount* for a bidder that qualifies for the small business bidding credit is:

$$\min \left\{ \$150 \text{ million}, BC \cdot \sum_{k \in C \setminus SM} AGP_k + \min \left\{ \$10 \text{ million}, BC \cdot \sum_{k \in C \cap SM} AGP_k \right\} \right\}$$

This calculation only considers markets for which an assignment has been processed. The calculation first caps the discount from small markets at 10 million, then adds the discount from all other markets and caps the total at 150 million.

8.2.2 For Total Payment/Commitment

For a bidder that qualifies for the rural bidding credit, the *capped total payment/commitment discount* is:

$$\min \left\{ \$10 \text{ million}, BC \cdot \left(\sum_{k \in C} AGP_k + \sum_{r \in N} d_r \cdot P_r \right) \right\}$$

That is, the sum of the bidder's gross adjusted payment and its gross unadjusted commitment is multiplied by its bidding credit percentage and capped at 10 million.

For a bidder that qualifies for the small business bidding credit, the *capped total payment/commitment discount* is:

$$\begin{aligned} & \min \left\{ \$150 \text{ million}, BC \cdot \left(\sum_{k \in C \setminus SM} AGP_k + \sum_{r \in N \setminus SP} d_r \cdot P_r \right) \right. \\ & \quad \left. + \min \left\{ \$10 \text{ million}, BC \cdot \left(\sum_{k \in C \cap SM} AGP_k + \sum_{r \in N \cap SP} d_r \cdot P_r \right) \right\} \right\} \end{aligned}$$

This calculation considers all markets, regardless of whether an assignment has been processed. The calculation first caps the discount from small markets at 10 million, then adds the discount from all other markets and caps the total at 150 million.

8.2.3 For Unadjusted Commitment

The capped unadjusted commitment discount is calculated as the difference between the capped total payment/commitment discount and the capped adjusted payment discount. This way the unadjusted commitment discount is capped based on the total discount. For example, if the capped adjusted payment discount for a rural bidder is \$10m, the capped unadjusted commitment discount will always be \$0m.

For a bidder that qualifies for the rural bidding credit, the capped unadjusted commitment discount is:

$$\min \left\{ \$10 \text{ million}, BC \cdot \left(\sum_{k \in C} AGP_k + \sum_{r \in N} d_r \cdot P_r \right) \right\} - \min \left\{ \$10 \text{ million}, BC \cdot \sum_{k \in C} AGP_k \right\}$$

For a bidder that qualifies for the small business bidding credit, the capped unadjusted commitment discount is:

$$\begin{aligned} & \min \left\{ \$150 \text{ million}, BC \cdot \left(\sum_{k \in C \setminus SM} AGP_k + \sum_{r \in N \setminus SP} d_r \cdot P_r \right) \right. \\ & \quad \left. + \min \left\{ \$10 \text{ million}, BC \cdot \left(\sum_{k \in C \cap SM} AGP_k + \sum_{r \in N \cap SP} d_r \cdot P_r \right) \right\} \right\} \\ & \quad - \min \left\{ \$150 \text{ million}, BC \cdot \sum_{k \in C \setminus SM} AGP_k + \min \left\{ \$10 \text{ million}, BC \cdot \sum_{k \in C \cap SM} AGP_k \right\} \right\} \end{aligned}$$

8.3 Net amounts

Each net amount is calculated as the difference between the corresponding gross amount and capped discount. In particular:

- A bidder's *net adjusted payment* is equal to the bidder's gross adjusted payment minus its capped adjusted payment discount.
- A bidder's *net unadjusted commitment* is equal to the bidder's gross unadjusted commitment minus its capped unadjusted commitment discount.

Once all assignment rounds have been processed, a bidder's net adjusted payment is equal to its final forward auction payment.

8.4 Uncapped Discounts

8.4.1 All Markets

For a bidder that qualifies for a bidding credit, the uncapped discount is calculated by multiplying the corresponding gross amount by the bidder's bidding credit percentage. In particular:

- A bidder's *uncapped adjusted payment discount* is equal to the product of the bidder's gross adjusted payment and its bidding credit percentage.
- A bidder's *uncapped unadjusted commitment discount* is equal to the product of the bidder's gross unadjusted commitment and its bidding credit percentage.

8.4.2 Small Markets Only

These calculations are relevant only for bidders that qualify for the small business bidding credit and will be additionally displayed only for those bidders.

The uncapped adjusted payment discount for small markets is:

$$BC \cdot \sum_{k \in C \cap SM} AGP_k$$

The uncapped unadjusted commitment discount for small markets only is:

$$BC \cdot \sum_{r \in N \cap SP} d_r \cdot P_r$$

9 Post-Auction per-License Price Calculations

While final forward auction payments for winning bidders will be calculated as in Section 7.4 above, with bidding credit caps and assignment phase payments applying on an aggregate basis, rather than for individual licenses, the auction system will also calculate a per-license price for each license. Such individual prices may be needed in the event that a licensee subsequently incurs license-specific obligations, such as unjust enrichment payments.¹³

After the assignment phase, the auction system will determine a net and gross post-auction price for each license that was won by a bidder by apportioning assignment phase payments and bidding credit discounts (only applicable for the net price) across all the licenses that the bidder won. To calculate the gross per-license price, the auction system will apportion the assignment phase payment to licenses in

¹³ 47 C.F.R. §.

proportion to the impairment adjusted price of the licenses that the bidder is assigned in that market. To calculate the net price, the auction system will first apportion any applicable bidding credit discounts to assignment phase markets in proportion to their adjusted gross payments. Then, for each assignment phase market, the auction system will apportion the assignment phase payment and the discount to licenses in proportion to the impairment adjusted price of the licenses that the bidder is assigned in that market.

The following notation will be used in this section:

- IAP_j denotes the impairment adjusted price of license j
- APP_k denotes the bidder's assignment phase payment for assignment phase market k
- AGP_k denotes the bidder's adjusted gross payment for assignment phase market k
- SM denotes the set of assignment phase markets that consist solely of PEAs subject to the small market bidding cap.¹⁴
- M denotes the set of assignment phase markets
- L_k denotes the set of licenses that the bidder was assigned in assignment phase market k
- TD denotes the total discount of the bidder

- o If the bidder qualifies for the rural bidding credit:

$$TD = \min \left\{ \$10 \text{ million}, BC \cdot \sum_{k \in M} AGP_k \right\}$$

- o If the bidder qualifies for the small business bidding credit:

$$TD = \min \left\{ \$150 \text{ million}, BC \cdot \sum_{k \in M \setminus SM} AGP_k + \min \left\{ \$10 \text{ million}, BC \cdot \sum_{k \in SM} AGP_k \right\} \right\}$$

Note that a bidder that qualifies for the small business bidding credit has reached the small markets cap if and only if

$$BC \cdot \sum_{k \in SM} AGP_k \geq \$10 \text{ million}$$

9.1 Apportioning discounts to assignment phase markets

This section describes how to apportion the bidder's total bidding credit discount across assignment phase markets. Let D_k denote the discount that is apportioned to assignment phase market k .

If the bidder does not qualify for any bidding credit discount, then $D_k = 0$.

If the bidder qualifies for the rural bidding credit *or* if the bidder qualifies for the small business bidding credit and did not reach the small markets cap, then

$$D_k = \frac{AGP_k}{\sum_{k' \in M} AGP_{k'}} \cdot TD$$

That is, the total discount is apportioned to assignment phase markets proportionally to the bidder's adjusted gross payments in each market.

If the bidder qualifies for the small business bidding credit and it reached the small markets bidding credit cap, then

- If $k \in SM$,

¹⁴ See note 12.

$$D_k = \frac{AGP_k}{\sum_{k' \in SM} AGP_{k'}} \cdot (\$10 \text{ million})$$

- If $k \notin SM$,

$$D_k = \frac{AGP_k}{\sum_{k' \in M \setminus SM} AGP_{k'}} \cdot (TD - \$10 \text{ million})$$

That is, the \$10 million discount that applies to small markets is apportioned to assignment phase markets that consist of PEAs subject to the small market bidding cap proportionally to the bidder's adjusted gross payments for those assignment phase markets. The remaining discount (*i.e.*, $TD - \$10 \text{ million}$) is apportioned among the assignment phase markets that consist of PEAs not subject to the small market bidding cap.

For each assignment phase market, the calculation is rounded down to the nearest dollar. The slack due to rounding down is then distributed (one dollar at a time) to assignment phase markets based on ascending order of the adjusted gross payments.

9.2 Apportioning assignment phase payments and discounts to licenses

Suppose that the bidder has been assigned license j in assignment phase market k .

The gross post-auction price of license j is determined by the following formula:

$$IAP_j + \frac{IAP_j}{\sum_{j' \in L_k} IAP_{j'}} \cdot APP_k$$

That is, for each assignment phase market, the assignment phase payment is apportioned to the licenses in that assignment phase market in proportion to the impairment adjusted price of each license. Note that if the bidder's assignment phase payment in an assignment phase market is zero, then the gross post-auction price of each license it is assigned in that market is simply the impairment adjusted final clock phase price for that license.

The net post-auction price of license j is determined by the following formula:

$$IAP_j + \frac{IAP_j}{\sum_{j' \in L_k} IAP_{j'}} \cdot (APP_k - D_k)$$

That is, for each assignment phase market, the difference between its assignment phase payment and its discount (see Section 9.1 for how the discount is determined) is apportioned to the licenses in that assignment phase market in proportion to the impairment adjusted price of each license. Note that if the bidder does not qualify for a bidding credit and its assignment phase payment in an assignment phase market is zero, then the post-auction price of each license it is assigned in that market is simply the impairment adjusted final clock phase price for that license.

Each license calculation is rounded down to the nearest dollar and then the slack due to rounding down is distributed to licenses (one dollar at a time) based on ascending order of the impairment adjusted prices.

ATTACHMENT 2**New Technical Appendices Relating to the Reverse Auction**

This page was intentionally inserted as a cover page for Attachment 2, which consists of the following technical appendices:

- APPENDIX I — Final Baseline
- APPENDIX J — Optimization to Determine Stations Not Needed
- APPENDIX K — Final TV-to-TV Constraints

APPENDIX I

Final Baseline

This page was intentionally inserted as a placeholder for Appendix I, which is available as a separate file.

APPENDIX J

Optimization to Determine Stations Not Needed

1 Introduction

This appendix describes the process for identifying “not-needed” stations pursuant to the Commission’s decision in the *Auction 1000 Bidding Procedures Public Notice*.¹ During the reverse auction, a station will become frozen if there is no feasible assignment for it in the station’s pre-auction band. If there is a feasible assignment, then the station’s price will continue to decrease. If a station *always* has a channel in its pre-auction band for a given clearing target, then the price offered for that station would eventually go to zero. Rather than have a station participate only to have the end result be that it is offered no remuneration for any of its relinquishment options, the Commission has established an optimization process that identifies these stations prior to the auction and informs them that they are not needed to participate and that each will be assigned to a channel in its pre-auction band.

This appendix first presents an overview of how the optimization process established by the Commission determines the stations not needed and provides a few simple examples that illustrate when a station will always have a channel available. The mathematical formulation of the optimization is then presented.

2 Overview of the Optimization Process

A separate optimization problem will be solved for each station. The optimization problem will consider all feasible assignments and determine if there exists *any* assignment that could block that study station from being assigned to any allowable channel in its pre-auction band (for UHF stations, this only considers channels up to the highest channel for that clearing target). Thus, the optimization examines implicitly *all* feasible assignments and seeks an assignment where the given station cannot be assigned in its pre-auction band. If any such assignment exists, then the station is considered “needed.” To find such an assignment, the optimization *minimizes* the number of “free channels” (channels that are not interfered with in this current assignment) available to the station. If the number of free channels is greater than or equal to one, then no matter what assignment is made, there will *always* be a free channel for this station. Furthermore, after stations are determined to be not needed, those stations can safely be removed from the assignment problems (as they will always have a channel available regardless of the assignment) and additional stations can be determined to be not needed.

Note that stations might be “needed” before participation is known or at the beginning of a stage of the reverse auction but might become “not needed” during the auction when more room becomes available in the station’s pre-auction band because other stations’ possible options have changed (*e.g.*, a UHF station exits the auction and can no longer block a VHF station). Thus, although the station is a participant in the first stage of the auction, it might no longer be needed at a future stage of the auction.

Thus, the determination of the stations that are not needed will be run at various times. It will first be run before the application window opens. It is also run during the determination of the initial clearing target. It will again be run before each additional stage of the reverse auction. Whenever it is determined that a station is not needed, the station will be informed of this fact and the price offered the station will be set to zero.

¹ See *Broadcast Incentive Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, GN Docket No. 12-268, AU Docket No. 14-252, 30 FCC Rcd 8975, 9022, para. 73 n.271 (2015) (*Auction 1000 Bidding Procedures PN*).

The benefits of finding unneeded stations are that it informs stations when their participation is no longer necessary. In addition, it informs those stations that are designated as “needed” that they have some probability of being compensated at the prices offered. This process of identifying stations not needed can also reduce the problem size of the Clearing Target Optimization and it may help the computations of the reverse auction feasibility checker.

The mathematical formulation of the optimization remains the same regardless of when it is invoked. What changes is the set of stations S considered in the model and the allowable channels for each station $s \in S$. The difference in the definitions of these sets after the formulation is explained below. First, a few examples are presented that show when a station would not be needed.

Simple Example

In this example, study station s_1 has two available channels (c_i and c_j). The study station has one co-channel interfering station s_2 with only one available channel c_j . Thus, the study station will always have a channel available to it namely c_i and is not needed.

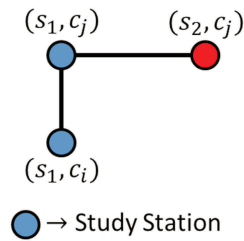


Figure 8: Study station s_1 is not needed

3 Optimization Concepts

Before providing the formulation for the problem, the concepts behind this optimization are described. As described earlier, if the minimum number of free channels of a study station in any assignment is larger than zero, then the station can always be assigned a channel in its pre-auction band. The optimization therefore asks the question “Among all feasible assignments, what is an assignment that minimizes the number of free channels for study station s ?” This optimization considers all other stations (both participating and non-participating) that could be assigned in the auction and allows such stations to be assigned *any* allowable channel in their domain set (for non-participating or exited stations, in their pre-auction band; for participating stations, in any of their possible relinquishment options and their pre-auction band), enforcing the requirement that any such assignment satisfies the interference constraints. Thus, this optimization considers all possible eventual assignments of these stations and seeks to find an assignment that minimizes the number of channels available to station s .

There are a few concepts that are necessary to understand this optimization:

- (1) The optimization includes all stations that could possibly be assigned to the study station’s pre-auction band at the end of the auction and thus allows *any* feasible assignment that could eventuate in the auction;
- (2) Non-participating or exited stations, if assigned a channel, can only be assigned one in their pre-auction band. Participating stations can be assigned to any *allowable* assignment;
- (3) An assignment must satisfy all of the co- and adjacent-pair interference constraints that define a feasible assignment;
- (4) The optimization is picking – among *all possible assignments* that could eventuate – an assignment that minimizes the number of free channels for study station s – or, equivalently, maximizes the number of channels blocked for s . If the number of free channels for a station is

greater than zero, then there will always be a channel available, although the actual free channel eventually assigned to this station may be different from the one found in the optimization.

4 Mathematical Formulation

In the mathematical formulations below, the following notation is used:

- s is the study station.
- S_s is the set of stations that could potentially block the study station. This set consists of any station that has a co-channel or adjacent channel relationship with the study station.
- $E_{s,c,c'}$ is the set of stations, on channel c' , which have a pairwise restriction (co-channel or adjacent) with study station s on channel c .
- C_i is the set of available channels for station i in S_s . For participating stations, this includes 0 if off-air is a possible option and lower band channels if those are possible options. For non-participant and exited stations, C_i only consists of channels in the pre-auction band for station i (including channels in the 600 MHz band for UHF stations).
- C_s^H is the set of available channels for station s in the pre-auction band for station s (up to the highest channel in a given clearing target for UHF stations).

Variable Definitions:

$f_{s,c}$ is equal to 1 if channel c is free for station s , or 0 otherwise.

$x_{i,c}$ is a binary decision variable, where the value is 1 if station i is assigned to channel c ($c \in C_i$), or 0 otherwise.

Given a study station s , and the set of all other stations with each station's possible options, the following model will compute the minimum number of free channels that are possible in any feasible assignment.

Model Formulation:

$$z = \min \sum_{c \in C_s^H} f_{s,c}$$

Subject to:

$$\sum_{i \in C_i} x_{s,c} \leq 1 \quad \forall i \in S_s / \{s\} \quad (1)$$

$$x_{i,c} + x_{i',c} \leq 1 \quad \forall \{(i,c), (i',c)\} \in CoPairs \quad (2)$$

$$x_{i,c} + x_{i',c'} \leq 1 \quad \forall \{(i,c), (i',c')\} \in AdjPair \quad (3)$$

$$x_{i,c} \in \{0,1\} \quad \forall c \in C_i, i \in S_s / \{s\} \quad (4)$$

$$f_{s,c} + \sum_{i \in E_{s,c,c-1}} x_{i,c-1} + \sum_{i \in E_{s,c,c}} x_{i,c} + \sum_{i \in E_{s,c,c+1}} x_{i,c+1} \geq 1 \quad \forall c \in C_s^H \quad (5)$$

$$f_{s,c} \in \{0,1\} \quad \forall c \in C_s^H \quad (6)$$

Explanation of Objective Function:

For all possible channels in the pre-auction band of the studied station s , all free channels are summed up to the highest channel available (excluding free channels in the wireless portion of the 600 MHz Band).

If $z \geq 1$ then the station is not needed to participate in the auction.

Explanation of Constraints:

Constraints (1)–(4) are the feasibility constraints. All stations, except for the study station, are assigned a channel that does not violate any of the co-channel or adjacent channel feasibility constraints. The last two constraints, (5) and (6), work to block the considered station s from being on channel c .

1. Every station must be assigned to a channel:

$$\sum_{c \in C_i} x_{i,c} \leq 1 \quad \forall i \in S_s / \{s\}$$

Each station except for the study station may be assigned to one of its available channels. Participant stations can be assigned to any channel that is a possible option for them. Non-participant stations and exited stations, if assigned a channel, will be assigned to a channel in their pre-auction band. Constraint (1) is less than or equal to in order to allow *any* feasible combination of interfering stations to block all available channels for this station.

2. Any assignment must adhere to co-channel interference constraints:

$$x_{i,c} + x_{i',c} \leq 1 \quad \forall \{(i,c), (i',c)\} \in CoPairs / \{s\}$$

No assignments are allowed that violate co-channel interference constraints.

3. Any assignment must adhere to adjacent channel interference constraints:

$$x_{i,c} + x_{i',c'} \leq 1 \quad \forall \{(i,c), (i',c')\} \in AdjPairs / \{s\}$$

No assignments are allowed that violate adjacent channel interference constraints.

4. The decision variables can only take on the values zero or one.

$$x_{i,c} \in \{0,1\} \quad \forall c \in C_i, i \in S_s / \{s\}$$

For each allowable station-channel combination, the value of the variable $x_{s,c}$ is restricted to be either 0 or 1, *i.e.*, the station is either assigned to the channel or it is not.

5. For study station s , either there exists a free channel or there exists at least one co-channel or adjacent channel interferer in the assignment:

$$f_{s,c} + \sum_{i \in E_{s,c,c-1}} x_{i,c-1} + \sum_{i \in E_{s,c,c}} x_{i,c} + \sum_{i \in E_{s,c,c+1}} x_{i,c+1} \geq 1 \quad \forall c \in C_s^H$$

This constraint forces $f_{s,c}$ to be equal to one whenever there is nothing blocking station s from being on channel c , *i.e.*, when all channel assignments for other stations do not block this station on this channel. The summations on the left-hand-side add up all possible blockings: the station blocks channel c because it has co-channel interference with station s *or* the station blocks channel c because it has adjacency interference with the study station either by being on a channel directly above it or directly below it. Since the optimization wants to minimize the sum of the $f_{s,c}$ variables, it will try and set $f_{s,c}$ to 0 in this constraint. Conversely, if the optimization cannot find an assignment such that there is at least one station that blocks the study station from using channel c , the constraint will force the $f_{s,c}$ variable to be 1 thus indicating that channel c is free. A constraint of this type is constructed for *every* available channel in the study station's pre-auction band.

6. The free channel variables can only take on the values of zero or one:

$$f_{s,c} \in \{0,1\} \quad \forall c \in C_s^H$$

For each allowable channel in the pre-auction band for station s , $f_{s,c} = 0$ if another station prevents station s from being assigned to channel c because of a co-channel or adjacent channel interference relationship. If no station blocks s from that channel, then $f_{s,c} = 1$.

5 Determining Set Definitions

There are a number of times when the optimization will be utilized to determine the stations not needed.

The first time this procedure is run is before the application window opens. In this instance, the most flexible case is assumed: every station can be assigned *any* channel in its domain thereby allowing the most adaptability for blocking the studied station.

The stations not needed procedure is also run when determining a clearing target. Here, the domain for participating stations is all channels that are allowable based on the commitments made in the application filing as well as channels in their pre-auction band. If the station has indicated it is willing to go off-air, then that option is also allowed. For stations not participating, the allowable channels are only those in its pre-auction band.

Finally, between stages in the auction, the procedure for determining stations not needed will also be executed. Any station that is no longer participating can only be assigned to a channel in its pre-auction band. Any participating station can be assigned to any channel that satisfies its current allowable relinquishment options as well as any channel in its pre-auction band.

APPENDIX K

Final TV-to-TV Constraints

1 Introduction

The *Repacking Data PN* released in July 2013 first proposed the methodology underlying the creation of pairwise TV-to-TV constraints which are used to restrict how the repacking software can repack television stations during the Incentive Auction.¹ This methodology was subsequently adopted by the Commission in the *Incentive Auction Report and Order*.² This appendix provides the final update to the process of generating TV-to-TV constraints resulting from the recently signed coordinations with Canada and Mexico³ and from changes to the final list of eligible stations in the United States.⁴

Accompanying the release of this appendix are final TV-to-TV constraint files:

- a) *Domain.csv* – defining the domain of available channels of any U.S. or Canadian station given certain fixed constraints.
- b) *Interference_Paired.csv* – defining which pairs of stations cannot operate co-channel, upper-adjacent channel or lower-adjacent channel to each other given the amount of potential interference between them, calculated using actual channels.

These constraint files (and the supporting input files) are accessible on the FCC’s LEARN website under the Repacking section.⁵

¹ See *Incentive Auction Task Force Releases Information Related to Incentive Auction Repacking*, GN Docket No. 12-268, ET Docket No. 13-26, Public Notice, 28 FCC Rcd 10370, 10385, 10387 (WTB 2013) (*Repacking Data PN*).

² See *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6567, 6620 (2014) (*Incentive Auction Report and Order*). The Commission noted that improved processing capabilities would allow it to move away from the use of proxy channels to actual (or specific channels) for TV-to-TV constraints. This change away from the use of proxy channels was further detailed in the *Aggregate Interference PN*. *Incentive Auction Task Force Releases Updated Constraint File Data Using Actual Channels and Staff Analysis Regarding Pairwise Approach to Preserving Population Served*, GN Docket No. 12-268, ET Docket No. 13-26, Public Notice, 29 FCC Rcd 5687 (June 2, 2014) (*Aggregate Interference PN*).

³ See *Broadcast Incentive Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, GN Docket No. 12-268, AU Docket No. 14-252, 30 FCC Rcd 8975, 8985–96, para. 16 (2015) (*Auction 1000 Bidding Procedures PN*) (“Application of this [initial clearing target] procedure will be subject to the international agreements we reach with Canada and Mexico.”); *Statement of Intent Between the Federal Communications Commission of the United States of America and the Department of Industry Canada Related to the Reconfiguration of Spectrum Use in the UHF Band for Over-the-Air Television Broadcasting and Mobile Broadband Services*, U.S.–Can., Aug. 11, 2015, available at <https://transition.fcc.gov/ib/sand/agree/files/PASHC.pdf> (*Canadian Coordination*); *Exchange of Coordination Letters with IFT Regarding DTV Transition and Reconfiguration of 600 MHz Band Spectrum*, U.S.–Mex., July 15, 2015, available at <http://wireless.fcc.gov/incentiveauctions/learn-program/resources.html> (*Mexican Coordination*).

⁴ The final baseline is included as App. I. See also *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 8983, para. 9 (directing OET to release final baseline coverage area and population data for each station to be protected).

⁵ See *Incentive Auctions – LEARN – Repacking*, FCC, <http://wireless.fcc.gov/incentiveauctions/learn-program/repacking.html> (last modified Nov. 3, 2014).

2 Changes Resulting from *Canadian Coordination*

Under the *Canadian Coordination*, Canada has agreed to jointly repack their operating stations together with U.S. stations during the auction.⁶ Pursuant to the provisions of the *Canadian Coordination*, operating Canadian stations will be treated the same as non-participating U.S. stations during the auction. Moreover, the *Canadian Coordination* no longer requires the protection of Canadian television allotments (whether occupied or unoccupied); rather, the U.S. only needs to protect Canadian stations at their actual operating parameters.

Pursuant to the *Canadian Coordination*, Canadian stations will now be added to the *interference_paired.csv* file and the *domain.csv* file. Moreover, because Canadian stations are no longer “fixed” on their original channel, U.S. stations along the Canadian border will no longer have channels removed in their domain as a result of Canadian stations causing more than 0.5 percent new interference on their current channel. Instead, U.S. stations along the Canadian border will now have pairwise constraints not only from other U.S. stations, but also from Canadian stations (if the 0.5 percent new interference threshold is violated for that specific station-channel combination).

The specific technical parameters used for determining Canadian stations protected contours and interference protections are listed in detail in Table 1-1 of Appendix 1 of the *Canadian Coordination*. In the constraint files (and in the output of *TV Study*), these Canadian stations will have facility IDs that range from [1000001, 2000000].

2.1 Special Case #1: Canadian Stations with Zero Interference-free Population

In Canada, there are a handful of stations that *TV Study* has calculated as having zero interference-free population because their calculated protected contour covers very rural areas. This is problematic because one cannot calculate an interference percentage for these stations (since the denominator = 0).

In this case, the Table 1-1 in Appendix 1 of the *Canadian Coordination* details a distance-based approach to protect these stations. The separation distance is 80 kilometers. These distance-based protections calculated using the Haversine Method are provided in a CSV file (*canada_distance_protected_stations.csv*) to the *Constraint Generator* software. The file contains 2 columns (1) facility ID, and (2) distance.

A value of “1500028, 80” means that “Any other facility that is within 80 km of facility 1500028 cannot be placed on the same channel as facility 1500028”. In this case, new records are manually inserted (for channels 2 – 51) into the pairwise interference table (in Postgres database) with an *interfered_population_percent* of “888” (which is greater than the threshold of 0.5%). For example, let’s assume the location of facility 1000001 is 72 km from facility 1500028. The following records are manually inserted into the pairwise table (for channels 2 through 51).

Facility_id	Channel_id	Interfering_facility_id	Interfering_channel_id	Interfered_population	Interference_free_pop	Interfered_population_percent
1500028	2	1000001	2			888
1500028	3	1000001	3			888
1500028	.	1000001	.			888
1500028	51	1000001	51			888

Because these records now exist in the pairwise interference table (in Postgres database), the *Constraint Generator* software will be able to add records to the *interference_paired.csv* constraint file which reflects these additional constraints (e.g., between facility 1500028 and 1000001).

⁶ See *Canadian Coordination* at 1.

2.2 Special Case #2: Protecting Adjacent +/- 2 for some Pairs of Canadian Stations

The *TVStudy* software and previously released constraint files assumes only co-channel and adjacent +/- 1 protections between facilities. So, if Facility A is on channel 26, the interfering channel will always equal 25, 26, or 27. The *Canadian Coordination*, however, specifies an exception to this rule for a limited set of pairs of Canadian stations. In Table 1-2 in Appendix 1 of the *Canadian Coordination* lists certain Canadian station pairs which require certain adjacent +/- 2 protections. This data is provided in a CSV file (*canada_plus_minus_2.csv*) to the *Constraint Generator* software.

This file has the following fields:

- facility_id: ID of protected Canadian facility
- interfering_facility_id: ID of interfering Canadian facility
- plus_two_indicator: 1 = protect adjacent + 2 for this protected facility, 0 = do not protect
- minus_two_indicator: 1 = protect adjacent - 2 for this protected facility, 0 = do not protect

In these cases, new records are manually inserted (for channels 2 – 51) into the pairwise interference table (in Postgres database) with an interfered_population_percent of “222” (which is greater than the threshold of 0.5%). For example, assume the following data was included in the CSV file “1000313, 1000254, 1, 1”. This would mean that facility 1000313 must be protected on both adjacent + 2 and adjacent – 2 for every channel (*i.e.*, facility 1000254 could never reside on a channel that was either +2 or -2 of the channel assignment of 1000313). The result would look something like this:

Facility_id	Channel_id	Interfering_facility_id	Interfering_channel_id	Interfered_population	Interference_free_pop	Interfered_population_percent
1000313	2	1000254	4			222
1000313	4	1000254	2			222
1000313	7	1000254	9			222
1000313	8	1000254	10			222
1000313	9	1000254	11			222
1000313	9	1000254	7			222
1000313	10	1000254	12			222
1000313	10	1000254	8			222
1000313	.	1000254	.			222
1000313	.	1000254	.			222
1000313	49	1000254	51			222
1000313	50	1000254	48			222
1000313	51	1000254	49			222

Notice that certain channels (such as 3, 5, 6) are missing from the data above. This is a result of spectrum “gaps” in the TV spectrum band. Three sets of these “gaps” exist:

- Between channels 4 and 5
- Between channels 6 and 7
- Between channels 13 and 14

For example, although channel 4 and 5 are adjacent to one another numerically, they are separated by a 4 MHz gap and no first adjacent constraints are considered between two stations on these two channels. So although there is 1 channel of separation between channel 3 and 5, there is a larger MHz gap between the

two and thus TV stations can reside without interference. In the above example, a record in the pairwise table for channel_id = 3 is not created because an adjacent + 2 would result in a channel assignment of 5 which crosses the spectrum gap between channels 4 and 5. Similarly, an adjacent -2 entry is not created in the table for channel_id = 6 because the adjacent -2 channel of 4 is consumed by the gap in spectrum.

Because these tables now exist in the pairwise interference table (in Postgres database), the *Constraint Generator* software will be able to add additional records to the *interference_paired.csv* constraint file which reflects these additional adjacent +2/-2 constraints (e.g., between facility 100313 and 1000254).

One additional point is worth noting: If an adjacent +2/-2 constraint exists between two Canadian stations, the *Constraint Generator* software will create adjacent +1/-1 constraints and co-channel constraints between these stations independent of what the pairwise interference table reports from *TVStudy*. This assumption is consistent with the existing rule followed by the *Constraint Generator* software that co-channel constraints between a station pair will automatically be created when adjacent +1/-1 constraints exist.

3 Changes Resulting from Mexican Coordination

Under the *Mexican Coordination*, Mexico and the United States have agreed to a channel plan which has identified future channels for operating Mexican stations (and a few television allotments for a future auction) along the border with the U.S. that essentially moves all their stations below channel 37 (with a few exceptions).⁷ Moreover, under the *Mexican Coordination*, the U.S. is no longer required to protect Mexican television allotments (whether occupied or not) using separation distances; rather, the published channel plan in the *Mexican Coordination* is based on pairwise interference studies using *TV Study* and actual operating parameters.

In addition, the channel plan in the *Mexican Coordination* provides each U.S. station along the Mexican border with a set of channels that Mexico has agreed the repacking software can place the U.S. station on during the auction. This means that U.S. stations along the Mexican border will have their domains reduced to only the channels listed in the *Mexican Coordination*. Because Mexican stations are considered “fixed” on their new channel assignments, Mexican stations are not added to either the *domain.csv* file or the *interference_paired.csv* file. The “reduced” domain for U.S. stations along the Mexican border is contained in a CSV file (*southern_border_domain_restrictions.csv*) which follows the exact format of the *domain.csv* file (but only contain a subset of U.S stations) and will be read by the *Constraint Generator* software to reduce the domains of U.S. stations contained in this new file.

However, the set of channels in the domains of these U.S. stations along the Mexican border are further reduced from the channels listed in the *Mexican Coordination*. Because the channels listed for U.S. stations in the *Mexican Coordination* were meant to be slightly more permissive (i.e., the set of channels that Mexico agreed could be used for particular U.S. stations but not necessarily the set of channels complying with all U.S. rules), the *Constraint Generator* software will consider (a) whether any channels should be removed due to a land mobile restriction in the United States and (b) whether *TV Study* has calculated greater than 0.5 percent new interference created by a Mexican station when the Mexican station is placed on its *future* channel (as specified in the *Mexican Coordination*).⁸ Because the *Constraint Generator* software does not know which channel the Mexican station will be placed on in the future, it needs to read in one additional CSV file (*MX_future_operating_channels.csv*). It should be noted that Mexican stations are assigned new facility IDs between [70000001, 8000000] in the *TV Study* software and in this new CSV file.

⁷ See *Mexican Coordination* at 1–2.

⁸ Note that there is also one Mexican station in the *MX_future_operating_channels.csv* that is placed on channel zero because it has been designated to be “floating” in the *Mexican Coordination* and therefore is considered to be off-air for purposes of this check.

4 Other Changes

In addition to the changes to the TV-to-TV constraint methodology precipitated by the international agreements, there are a few additional changes incorporated in this latest set of constraint files.

4.1 Updates to Station Lists

Importantly, the final constraints reflect the final list of eligible stations in the U.S. This updated set of stations, which is incorporated in these new constraints, is listed in the *Parameter* file (*parameter.csv*) generated by *TVStudy* when conducting the pairwise study which underlies the constraint files. Because Canadian stations are now jointly repacked with U.S. stations, the Canadian stations were studied as both “desired” and “undesired” in *TVStudy*. Mexican stations are also included in the *Parameter* file (listed on their current channel) in order to calculate accurate interference-free populations for U.S. stations. Moreover, because the *Mexican Coordination* does require certain Mexican stations to move to new channels (particularly those currently above channel 37), Mexican stations were also studied as both “desired” and “undesired” in this *TVStudy* run.

As mentioned above, a key change resulting from both the *Canadian Coordination* and *Mexican Coordination* is that the U.S. no longer has to protect occupied/unoccupied allotments in either Canada or Mexico (with a few exception of a few auction allotments in Mexico). Thus, there is no longer any need to provide a separate list of Canadian and Mexican allotments in the *Constraint Generator* software. Similarly, this *Parameter* file replaces the “*US Station Baseline*” files that accompanied previous constraint file releases.

4.2 Updates to Land Mobile Lists

As with prior constraint file releases, the lists of Land Mobile City Centers and Land Mobile Waiver Stations that have to be protected during the repacking process have been updated with the final base station lists. These updates are captured in two CSV files: (a) *us_lm_stations.csv* and (b) *us_lmw_stations.csv*. As before, the following distance separations were used to determine which stations needed particular channels removed from their domains as a result of land mobile locations (including both Land Mobile City Centers and fixed land mobile waiver locations).

The distance restrictions are as follows:

- Land Mobile Co-channel: 250 km
- Land Mobile Adjacent +/- 1: 176 km
- Land Mobile Waiver Co-channel: 185 km
- Land Mobile Waiver Adjacent +/- 1: 96 km

The distances from each LM and LMW facility to every US facility is calculated using Haversine and these tables are used by the *Constraint Generator* software to further restrict a station’s *domain.csv* file. One noteworthy change from prior constraint file releases is that the list of Land Mobile City Centers no longer includes Detroit and Cleveland because land mobile operations are not permitted to operate on these channels despite being listed in the list of City Centers.⁹

⁹ 47 C.F.R. § 90.303(b) n.2. Moreover, as with prior repacking constraint releases, a “hypothetical” land mobile base station is added to the list of Land Mobile Waiver Base Stations to provide additional protection to T-Band operations in Suffolk County, NY on Channel 16. Because eligibility in the Public Safety Radio Pool can operate without a waiver in this county, which extends a significant distance from the New York urbanized area geographic center, FCC staff created a hypothetical land mobile base station which operated close to the middle of Suffolk County (40° 48' 26.17”N and 73° 0' 21.12”W) to ensure adequate protection. This hypothetical base station can be found in the newly released list of Land Mobile Waiver Base Stations. See 47 C.F.R. § 90.303(c) (outlining use of Channel 16 in Suffolk County).

The LM table (*us_lm_stations.csv*) and the LMW table (*us_lmw_stations.csv*) have the following fields:

LM Table

Data Element	Data Type
facilityid	integer
callsign	character varying(5)
channel	integer
city	character varying(100)
state	character varying(2)
latitude degree	numeric
latitude minute	numeric
latitude second	numeric
longitude degree	numeric
longitude minute	numeric
longitude second	numeric
latitude	numeric
longitude	numeric
station flag ¹⁰	character varying(1)

LMW Table

Data Element	Data Type
facilityid	integer
callsign	character varying(10)
channel	integer
service	character varying(2)
county	character varying(20)
state	character varying(2)
location number	integer
location type	character varying(20)
latitude degree	numeric
latitude minute	numeric
latitude second	numeric
latitude direction	character varying(20)
longitude degree	numeric
longitude minute	numeric
longitude second	numeric
longitude direction	character varying(20)
latitude	numeric
longitude	numeric
station flag ¹⁰	character varying(1)

4.3 Special Case #1: Land Mobile Restrictions to Ignore

There is one new exception to the land mobile restrictions created by these separation distances. Due to a special situation in Scranton,¹¹ a subset of stations (WNEP-TV, WVIA-TV and WOLF-TV) on the same mountain top (Penobscot Knob, or Penobscot Mountain) will be allowed to be assigned to channel 16 despite a land mobile station operating within distance separation zone. This is because land mobile operations need to protect this television allotment on channel 16 in Scranton. This data is provided to us via CSV file (*lm_lmw_station_channel_exception.csv*). This CSV file has two columns (1) facilityid, and (2) channel. For example, for the data “47929, 16”, we would delete records where *facilityid* = 47929 and *channel* = 16 in the *lm_lmw_interference* table. That is, due to this manual constraint relaxation, facility 47929 would be allowed to occupy channel 16 even though it falls within the restricted LM/LMW distances.

¹⁰ As a reminder, the station flag field can only be a “C” (indicating that the land mobile city center/base station is “considered” in the constraints) or an “N” (indicating that the land mobile city center/base station is “not considered” in the constraints).

¹¹ 47 C.F.R. § 90.303(c)(2)(ii).

4.4 Removal of Channels from Unavailable Bands

One last change made to this set of constraints is the removal of channels from “unavailable” bands in both the *interference_paired.csv* file and the *domain.csv* file. Thus, if a station’s pre-auction band is in High-VHF, it will no longer include channels in the UHF band in either constraint file because the auction rules do not allow stations to move to a higher (by frequency) band. As a further example, a Low-VHF station will no longer include channels in either the UHF band or High-VHF band since such a station cannot be repacked into either higher band. Finally, Canadian operating stations now listed in the constraint files will only include channels in their home band, since they are not allowed to be repacked out of their home band.

This change was made simply to simplify the constraints.

ATTACHMENT 3

List of Reserve-Eligible Nationwide Providers in Each PEA

This page was intentionally inserted as a placeholder for Attachment 3, which is available as a separate file.

ATTACHMENT 4

Supplemental Final Regulatory Flexibility Analysis

1. As required by the Regulatory Flexibility Act of 1980, as amended (“RFA”),¹ the Commission has prepared this Supplemental Final Regulatory Flexibility Analysis (“SFRFA”) of the possible significant economic impact on small entities by the procedures and instructions described in this *Auction 1000 Application Procedures PN*.

A. Need for, and Objectives of, Public Notice

2. The *Auction 1000 Application Procedures PN* implements the procedures established in the Commission’s prior orders to carry out the broadcast television spectrum incentive auction, which is scheduled to begin on March 29, 2016, and consists of the reverse auction (Auction 1001) and the forward auction (Auction 1002). In the *Auction 1000 Comment PN*, the Commission sought comment on the proposals for conducting the incentive auction, including the proposed procedures for the forward auction, the reverse auction, and the integration of the reverse and forward auctions, that would implement rules previously proposed in the *Incentive Auction NPRM* and adopted in the *Incentive Auction R&O*.² In the *Auction 1000 Bidding Procedures PN*, the Commission established the bidding procedures for the reverse and forward auctions.³ Pursuant to the Commission’s direction, this Public Notice establishes the application procedures for the reverse and forward auctions; provides detailed information, instructions, and deadlines for filing applications; and finalizes certain post-auction procedures established by the Commission’s prior orders.

3. Previously, as required by the RFA, the Commission prepared an Initial Regulatory Flexibility Analysis (“IRFA”) in connection with the *Incentive Auction NPRM* and a Final Regulatory Flexibility Analysis (“FRFA”) in connection with the *Incentive Auction R&O*.⁴ Likewise, the Commission’s *Mobile Spectrum Holdings NPRM* included an Initial Regulatory Flexibility Analysis and the *Mobile Spectrum Holdings R&O* included a Final Regulatory Flexibility Analysis (“MSH FRFA”).⁵ Recently, the Commission modified its Part 1 competitive bidding rules, including the designated entity rules that apply to all licenses acquired with bidding credits, including those won in Auction 1002. The

¹ See 5 U.S.C. § 604. The RFA, see 5 U.S.C. §§ 601 et seq., has been amended by the Small Business Regulatory Enforcement Fairness Act of 1996 (“SBREFA”), Pub. L. No. 104-121, Title II, 110 Stat. 847 (1996).

² See *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Notice of Proposed Rulemaking, 27 FCC Rcd 12357 (2012) (*Incentive Auction NPRM*); *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Report and Order, 29 FCC Rcd 6567 (2014) (*Incentive Auction R&O*).

³ See *Broadcast Auction Scheduled to Begin March 29, 2016; Procedures for Competitive Bidding in Auction 1000, Including Initial Clearing Target Determination, Qualifying to Bid, and Bidding in Auctions 1001 (Reverse) and 1002 (Forward)*, GN Docket No. 12-268, AU Docket No. 14-252, Public Notice, 30 FCC Rcd 8975 (2015) (*Auction 1000 Bidding Procedures PN*).

⁴ *Incentive Auction R&O*, App. B, 29 FCC Rcd at 6947-66; *Incentive Auction NPRM*, App. B, 20 FCC Rcd at 12523-44.

⁵ *Policies Regarding Mobile Spectrum Holdings; Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, Report and Order, 29 FCC Rcd 6133, App. C at 6250–62 (*Mobile Spectrum Holdings Report and Order*); see *Policies Regarding Mobile Spectrum Holdings*, WT Docket No. 12-169, Notice of Proposed Rulemaking, 27 FCC Rcd 11710, App. B at 11737-52 (2012) (*Mobile Spectrum Holdings NPRM*).

Part 1 NPRM and *Part 1 PN* included an IRFA and Supplemental IRFA respectively, and the resulting *Part 1 R&O* included a Final Regulatory Flexibility Analysis (“Part 1 FRFA”).⁶

4. Following the release of the *Auction 1000 Comment PN*, a *Supplemental Public Notice* sought comment on how the proposals in the *Auction 1000 Comment PN* could affect either the IRFA or the FRFA.⁷ The *Supplemental Public Notice* provided that the proposals in the *Auction 1000 Comment PN* did not change any of the matters described in the IRFA or FRFA.⁸ As further noted in the *Supplemental Public Notice*, the request for comment focused on how the proposals in the *Auction 1000 Comment PN* might affect either the IRFA or the FRFA.⁹

5. The subsequent *Auction 1000 Bidding Procedures PN* included a Supplemental Final Regulatory Flexibility Analysis (“Bidding Procedures PN SFRFA”) that addressed any determinations by the Commission that might have affected the IRFA and FRFA.¹⁰ As discussed in the Bidding Procedures PN SFRFA, one commenter responded to the *Supplemental Public Notice*. The SFRFA addressed this response accounting for any particular impact on small businesses and explaining the reasons supporting the Commission’s decisions.¹¹ Aside from those comments that have been addressed in the *Auction 1000 Bidding Procedures PN* and the associated SFRFA, no other comments have been filed in response to the *Supplemental Public Notice* or the application procedures and instructions set forth in this Public Notice. As such, the procedures and instructions in this Public Notice do not change the analysis set forth in the IRFA, FRFA, and Bidding Procedures PN SFRFA. This SFRFA summarizes the application procedures in this Public Notice to assure that the Wireless Telecommunications Bureau (“Bureau”) has accounted properly for any economic impact on small businesses, consistent with the IRFA and FRFA.¹²

6. Under the application procedures governing the conduct of the reverse auction, licensees of commercial and noncommercial educational full power and Class A television stations (“eligible broadcast licensees”) identified in the Final Baseline may apply to participate in the reverse auction.¹³ On its application (“FCC Form 177”), an eligible broadcast licensee will have up to three bid options depending on its pre-auction band: (1) go off-air (available to all stations); (2) move to a Low-VHF channel (available to UHF or High-VHF stations); and (3) move to a High-VHF channel (available only to UHF stations).¹⁴ Additionally, if the applicant’s application is timely-filed and deemed complete, it

⁶ See *Updating Part 1 Competitive Bidding Rules*, WT Docket No. 14-170, Report and Order, 30 FCC Rcd 7493, App. B at 7613–28 (2015) (*Part 1 R&O*); *Updating Part 1 Competitive Bidding Rules*, Public Notice, 30 FCC Rcd 4153, 4168–4174, paras. 33–50; *Updating Part 1 Competitive Bidding Rules*, Notice of Proposed Rulemaking, 29 FCC Rcd 12426, App. B at 12488–12501 (2014) (*Part 1 NPRM*).

⁷ *Comment Sought with Respect to Regulatory Flexibility Act and Paperwork Reduction Act in Connection with Competitive Bidding Procedures for Broadcast Incentive Auction 1000, Including Auctions 1001 and 1002*, GN Docket No. 12-268, AU Docket No. 14-252, Public Notice, 30 FCC Rcd 192 (2015) (*Supplemental Public Notice*).

⁸ *Supplemental Public Notice*, 30 FCC Rcd at 193.

⁹ See *id.*

¹⁰ See *Auction 1000 Bidding Procedures PN*, App. C, 30 FCC Rcd at 9111–15.

¹¹ See *id.* at 9112–15, paras. 5–18.

¹² Please refer to this Public Notice for a detailed discussion of these procedures and instructions.

¹³ *Incentive Auction R&O*, 29 FCC Rcd at 6716–17, para. 352. Licensees of LPTV and TV translator stations are not eligible to participate in the reverse auction. *Id.*; see also *Expanding the Economic and Innovation Opportunities of Spectrum Through Incentive Auctions*, GN Docket No. 12-268, Second Order on Reconsideration, 30 FCC Rcd 6746, 6811, para. 145 (*Second Order on Reconsideration*). For the Final Baseline, see Appendix I in Attachment 1 (Final Baseline) of this Public Notice.

¹⁴ See *Auction 1000 Bidding Procedures PN*, 30 FCC Rcd at 9009, para. 50. An applicant that intends to relinquish its spectrum usage rights in order to share a channel with a station that will remain on the air following the auction (continued....)

must then commit, at the associated opening price, to a preferred relinquishment option for each station for which it wishes to place bids in the clock rounds. Reverse auction bidders will be able to participate in the reverse auction over the Internet using the Commission's Auction System.

7. In the forward auction, each applicant must submit electronically through the Commission's Auction System a complete, accurate, and timely application ("FCC Form 175"), and submit a timely and sufficient upfront payment. Each stage of forward auction will consist of two phases—an ascending clock phase and an assignment phase. Forward auction bidders will also be able to participate in the forward auction over the Internet using the Commission's Auction System. Following the completion of the reverse and forward auctions,¹⁵ the Media and Wireless Bureaus (the "Bureaus") will release a *Channel Reassignment PN* that will provide the results of the reverse auction, the forward auction, and the repacking, indicating the reassignment of the television channels and reallocation of broadcast television spectrum, among other things.

B. Summary of Significant Issues Raised by Public Comments in Response to the Supplemental Notice

8. As noted above, the Bidding Procedures PN SFRFA addressed the only response to the *Supplemental Public Notice*, and no subsequent comments were filed in response to the *Supplemental Public Notice*.¹⁶ Thus, no specific alternative procedures were raised for consideration by the Bureau. However, the Bureau considered the potential impact of the auction procedures and instructions in this Public Notice on all potential participants, including small businesses.

9. Pursuant to the Small Business Jobs Act of 2010, the Commission is required to respond to any comments filed by the Chief Counsel for Advocacy of the Small Business Administration ("SBA"), and to provide a detailed statement of any change made to the proposed rules as a result of those comments. The Chief Counsel did not file any comments in response to the *Auction 1000 Comment PN* or the *Supplemental Public Notice*.

C. Description and Estimate of the Number of Small Entities to which Specified Auction 1000 Procedures Will Apply.

10. The RFA directs agencies to provide a description of and, where feasible, an estimate of the number of small entities that may be affected by rules proposed in that rulemaking proceeding, if adopted.¹⁷ The RFA generally defines the term "small entity" as having the same meaning as the terms "small business," "small organization," and "small governmental jurisdiction."¹⁸ In addition, the term "small business" has the same meaning as the term "small business concern" under the Small Business Act.¹⁹ A small business concern is one which: (1) is independently owned and operated; (2) is not

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will bid to go off-air. *See id.*; *see also* 47 U.S.C. § 1452(a)(2) (providing that options available in the reverse auction shall include a bid to relinquish usage rights in order to share a channel with another licensee).

¹⁵ The Commission determined in the *Incentive Auction R&O* that the reverse and forward auctions will be "complete" when a public notice announces that each auction, respectively, has ended. *Incentive Auction R&O*, 29 FCC Red at 6783–84, para. 529; 47 C.F.R. § 1.2208.

¹⁶ On October 7, 2015, AT&T submitted an *ex parte* supporting an additional default payment of 20 percent for Auction 1002. *See* AT&T Oct. 7, 2015 *Ex Parte* Letter at 2. We do not address the additional issues raised in AT&T's *ex parte* letter as they are beyond the scope of this Public Notice.

¹⁷ 5 U.S.C. § 604(a)(4).

¹⁸ 5 U.S.C. § 601(6).

¹⁹ 5 U.S.C. § 601(3) (incorporating by reference the definition of "small business concern" in the Small Business Act, 15 U.S.C. § 632). Pursuant to 5 U.S.C. § 601(3), the statutory definition of a small business applies unless an agency, after consultation with the Office of Advocacy of the SBA, and after opportunity for public comment,

(continued....)

dominant in its field of operation; and (3) satisfies any additional criteria established by the Small Business Administration (“SBA”).²⁰ Auction 1000 is the first-of-its-kind incentive auction and participation is voluntary; therefore, the Bureau cannot make a meaningful estimate of the number of small entities who may apply to participate in the reverse and forward auctions. However, the Bureau anticipates greater participation by small businesses in the forward auction due to the recent changes in the Commission’s designated entity rules aimed at providing greater opportunities for small businesses to gain access to capital in order to participate meaningfully at Commission auctions, including Auction 1002.²¹ Because this Public Notice implements those procedures and policies established in the Commission’s orders relating to Auction 1000, the procedures, terms, and conditions set forth in this Public Notice may affect the same individuals and entities described in paragraphs 14 through 36 of the FRFA, paragraphs 5 through 30 of the MSH FRFA, and paragraphs 9 through 35 of the Part 1 FRFA.²²

D. Description of Projected Reporting, Recordkeeping, and Other Compliance Requirements.

1. Some of the application procedures contained in this Public Notice will affect reporting, recordkeeping, and other compliance requirements for small entities. However, as discussed above, these procedures implement the rules and policies established in the Commission’s orders, including the factual, policy, and legal analyses supporting those policies.²³ Additionally, no comments were filed in response to these particular procedures and the Bureau intends to apply them uniformly to all entities, including small businesses.²⁴ However, to the extent that some of the procedures in this Public Notice may provide supplemental information for small businesses as discussed herein, we summarize the relevant procedures below.²⁵

1. Reverse Auction (Auction 1001)

2. Red Light Rule. To encourage broadcaster participation in the reverse auction, in this Public Notice, the Bureau waives the red light rule²⁶ for the limited purpose of permitting any licensee that is red lighted for debt owed to the Commission at the time it submits a reverse auction application to participate in the reverse auction. Because a reverse auction applicant may incur debt to the Commission after submission of its application, and may fail to pay the debt when due, to participate in the auction, each reverse auction applicant will be required to certify in its application that it (1) acknowledges its liability to the Commission for any debt owed to the Commission that the applicant incurred before, or that it may incur after, the reverse auction application deadline, including all accrued interest, penalties and costs, and that the debt will continue to accrue interest, penalties and costs until paid; and (2) agrees that the Commission may pay all debt owed by the applicant to the Commission from the applicant’s

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establishes one or more definitions of such term which are appropriate to the activities of the agency and publishes such definition(s) in the Federal Register.

²⁰ 15 U.S.C. § 632(a)(1996).

²¹ *Part 1 R&O*, 30 FCC Rcd 7493.

²² *Incentive Auction R&O*, App. B, 29 FCC Rcd at 6949–59, paras. 14-36; *Mobile Spectrum Holdings Report and Order*, App. C, 29 FCC Rcd at 6250-61, paras. 5-30; *Part 1 R&O*, App. B, 30 FCC Rcd at 7615-7625, paras. 9-35.

²³ See § A.

²⁴ On October 7, 2015, AT&T submitted an *ex parte* supporting an additional default payment of 20 percent for Auction 1002. See AT&T Oct. 7, 2015 *Ex Parte* Letter at 2. We do not address the additional issues raised in AT&T’s *ex parte* letter as they are beyond the scope of this Public Notice.

²⁵ For a more detailed description of this information, please § II. (Applying To Participate in the Reverse Auction) and § III. (Applying To Participate in the Forward Auction) of this Public Notice.

²⁶ Under the red light rule, the Commission will not process applications and other requests for benefits by parties that owe non-tax debt to the Commission. 47 C.F.R. § 1.1910(b)(2).

share of auction proceeds. Each reverse auction applicant will also be required to certify its agreement that if an appeal of, or request for waiver or compromise of, any debt owed by the applicant to the Commission is pending at the conclusion of the incentive auction, the Commission may withhold so much of the applicant's share of the auction proceeds as is necessary to pay the debt in full, including accrued interest, penalties and costs, until issuance of a final non-appealable decision regarding the debt or waiver or compromise request, and may then pay the debt from the applicant's withheld share.

3. Channel Sharing Certification. In the *Incentive Auction R&O*, the Commission adopted rules requiring prospective sharer stations under pre-auction channel sharing agreements ("CSAs") to make certain certifications concerning their channel sharing arrangements.²⁷ In addition to the certifications adopted in the *Incentive Auction R&O*, a sharer station must also certify that the CSA submitted by the reverse auction applicant is a true, correct, and complete copy of the CSA between the parties.

4. Provisions Regarding Pending Proceedings. As described in detail above, each reverse auction applicant that selects going off-air as a bidding option for a station must indicate on its FCC Form 177 whether it will hold any other broadcast licenses if all of the bids that it might place to go off-air are accepted. If it will hold another broadcast license, then the applicant must certify that the applicant will remain subject to any license renewal, as well as any enforcement action, pending at the time of the auction application deadline against the station that may go off-air as a result of the auction.²⁸ If it will not hold any other broadcast licenses, then the applicant must certify in its application (1) that pursuant to the Commission's announced procedures for resolving such matters in connection with this auction, the Commission may withhold a portion of the share of auction proceeds for the station, if any, pending final determination of any FCC liabilities with respect to the station and such portion may be applied towards the satisfaction of such liabilities;²⁹ and (2) that the applicant remains subject to the Commission's jurisdiction and authority to impose enforcement or other FCC liabilities with respect to the station, notwithstanding the surrender of its license for the station.³⁰

5. Additionally, each reverse auction applicant must also indicate for each license identified in its application whether the license is subject: (1) to a non-final revocation order; or (2) has expired or been cancelled and is subject to a non-final license cancellation order. An applicant that includes a Class A television station in its application must indicate whether that station is subject to a non-final downgrade order. If an applicant indicates that a license in its application is subject to any of the foregoing revocation, cancellation, or downgrade proceedings, it must certify in its application that it agrees with the Commission's announced procedures to withhold all of any incentive payment for the station pending the final outcome of any such proceeding.

6. All auction proceeds held (i) to cover potential enforcement liabilities, (ii) because of an ongoing license validity or downgrade proceeding, or (iii) until final resolution of an appeal of a debt determination or a compromise or waiver request will be held by the Commission in the U.S. Treasury. As determined by the Commission in the *Incentive Auction R&O*, amounts held following the auction will be released to the broadcaster or applied towards any forfeiture costs and other debt the broadcaster owes to the Commission, as appropriate in light of the final resolution of the relevant issues.

²⁷ See 47 C.F.R. § 1.2204(c)(5)(vii); *Incentive Auction R&O*, 29 FCC Rcd at 6746, para. 428. The applicant relinquishing spectrum is known as the "sharee" and the station whose channel will host the sharee is known as the "sharer."

²⁸ See 47 C.F.R. § 1.2204(c)(4)(ii).

²⁹ See 47 C.F.R. § 1.2204(c)(4)(iii).

³⁰ See *Auction 1000 Comment PN*, 29 FCC Rcd at 15778-79, para. 82.

2. Forward Auction (Auction 1002)

7. Certification of Eligibility for Reserved Spectrum. Under this certification requirement, a forward auction applicant that is eligible to bid on reserved spectrum blocks in a given PEA, and that included the PEA in its license area selection(s), must certify its eligibility to bid for reserved blocks in the PEA. An applicant is not required to bid on, or certify its eligibility for, reserved spectrum blocks in any or all areas in which it is eligible. However, an applicant that does not certify its eligibility with respect to a particular license area because it is not eligible or it declines to do so will not be able to bid for reserved spectrum blocks in that PEA during the auction.

8. Additional Default Payment. Any winning bidder that defaults or is disqualified after the close of the auction (i.e., fails to remit the required down payment within the prescribed period of time, fails to submit a timely FCC Form 601 post-auction application, fails to make full payment, or is otherwise disqualified) will be subject to the payments described in section 1.2104(g)(2).³¹ The default payment consists of a deficiency payment, equal to the difference between the amount of the Auction 1002 bidder's winning bid³² and the amount of the winning bid the next time a license covering the same spectrum is won in an auction, plus an additional payment equal to a percentage of the defaulter's bid or of the subsequent winning bid, whichever is less. For Auction 1002, the additional default payment will be 20 percent.

E. Steps Taken to Minimize the Significant Economic Impact on Small Entities, and Significant Alternatives Considered.

9. The RFA requires an agency to describe any significant alternatives beneficial to small entities considered in reaching a proposed approach, which may include the following four alternatives (among others): (1) establishment of differing compliance or reporting requirements or timetables that take into account the resources available to small entities; (2) clarification, consolidation, or simplification for small entities of compliance and reporting requirements; (3) use of performance, rather than design, standards; and (4) an exemption for small entities.³³ The procedures, terms, and conditions in this Public Notice correlate to those proposals and policies articulated in the Commission's orders governing Auction 1000, including Auctions 1001 and 1002. As such, a description of the steps taken to minimize the significant economic impact and the alternatives considered for these proposals can be found in the FRFA, Bidding Procedures PN SFRFA, MSH FRFA, and Part 1 FRFA.³⁴

10. In this Public Notice, the Bureau describes the application procedures and instructions for Auctions 1001 and 1002, along with the post-auction process, which are summarized in this supplemental analysis.³⁵ The policies adopted throughout the course of the incentive auction proceeding are consistent with the Commission's statutory obligations to "ensure that small businesses, rural telephone companies, and businesses owned by members of minority groups and women are given the opportunity to participate in the provision of spectrum-based services."³⁶ The statute also directs the Commission to promote "economic opportunity and competition . . . by avoiding excessive concentration of licenses and by

³¹ 47 C.F.R. § 1.2104(g)(2).

³² In this context, the "winning bid" refers to the calculated license price discussed in § IV.C.1 (Calculating Individual License Prices) and set forth in § 9 of Appendix H in Attachment 1 (Forward Auction Assignment Phase and Post-Auction License Prices) to this Public Notice.

³³ 5 U.S.C. § 604(a)(6).

³⁴ *Incentive Auction R&O*, App. B, 29 FCC Rcd at 6964–6966, paras. 55–62; *Auction 1000 Bidding Procedures PN*, App. C, 30 FCC Rcd at 9113–15, paras. 11–18; *Mobile Spectrum Holdings Report and Order*, App. C, 29 FCC Rcd at 6262, para. 32; *Part 1 R&O*, App. B, 30 FCC Rcd at 7625–28, paras. 36–46.

³⁵ See § A.

³⁶ 47 U.S.C. § 309(j)(4)(D).

disseminating licenses among a wide variety of applicants, including small businesses.”³⁷ For instance, the Commission concluded in the *Incentive Auction R&O* that licensing on a PEA basis is consistent with the requirements of section 309(j) because it would promote spectrum opportunities for carriers of different sizes, including small businesses.³⁸ Moreover, the Commission recently revised its designated entity rules to provide small businesses with more flexibility to find the capital needed for acquiring licenses in auctions by, for instance, eliminating the attributable material relationship rule (AMR rule) and increasing the gross revenue thresholds used for determining eligibility for small business bidding credits.³⁹

11. For Auction 1000, the Bureau has taken steps to minimize the administrative burdens for applicants throughout the application process while providing small businesses with the opportunity to participate in the reverse and forward auctions. These steps include, but are not limited to: (1) establishing auction websites as a central repository for auction information in addition to other Commission databases (e.g., ULS, CDBS) and making such online resources available at no charge for prospective applicants to research auction application and bidding procedures as well as Commission rules, policies, and other applicable decisions;⁴⁰ (2) publishing public notices at key points of the reverse and forward auction processes to keep auction applicants informed of their application status, applicable auction requirements, and relevant deadlines; (3) organizing, for reverse auction applicants, several workshops to address the auction application and bidding processes; (4) providing web-based, interactive online tutorials for prospective bidders to walk through the auction process and the Auction System’s application and bidding screens; (5) implementing a mock auction for all qualified bidders to obtain hands-on experience with the Commission’s Auction System prior to the start of the reverse and forward auctions; (6) conducting both auctions electronically over the Internet using the Commission’s Auction System to include providing online availability of round results and auction announcements; and (7) providing Commission staff to answer technical, legal, and other auction-related questions.

12. Although the processes surrounding the implementation of Auction 1000 are unique, the timelines from the announcement of Auction 1000 to the execution of the reverse and forward auctions were developed with the consideration of lowering costs and burdens of compliance with the Commission’s competitive bidding and media rules for all applicants, including small businesses. Following the conclusion of Auction 1000, the Bureaus will continue to provide information and services to auction applicants to facilitate compliance with the Bureaus’ competitive bidding and media rules in the form of additional public notices and continued support by Commission staff. In summary, a number of application procedures which will be implemented in Auction 1000 were designed to facilitate auction participation by all interested applicants, including small businesses.

F. Report to Small Business Administration

13. The Commission’s Consumer and Governmental Affairs Bureau, Reference Information Center, will send a copy of the *Auction 1000 Application Procedures Public Notice*, including this SFRFA, to the Chief Counsel for Advocacy of the SBA. A summary of this Public Notice, including this supplemental analysis, will also be published in the Federal Register.⁴¹

³⁷ 47 U.S.C. § 309(j)(3)(B).

³⁸ See *Incentive Auction R&O*, 29 FCC Rcd at 6603-04, para. 80.

³⁹ See *Part 1 R&O*, 30 FCC Rcd at 7502-07, paras. 18-28, 7523-25, paras. 72-75.

⁴⁰ See, e.g., Auction 1000 website, FCC, www.fcc.gov/auctions/1001 (last visited at Oct. 16, 2015); Auction 1001 website (Reverse Auction), FCC, www.fcc.gov/auctions/1001 (last visited at Oct. 16, 2015); Auction 1002 website (Forward Auction), FCC, www.fcc.gov/auctions/1002 (last visited at Oct. 16, 2015); *Incentive Auctions*, FCC, <https://www.fcc.gov/incentiveauctions> (last visited Oct. 13, 2015); *Incentive Auctions – LEARN – Repacking*, FCC, <http://wireless.fcc.gov/incentiveauctions/learn-program/repacking.html> (last modified Nov. 3, 2014).

⁴¹ See 5 U.S.C. § 604(b).